City, County and State

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Sewerage and Sewage Treatment | Highways and Streets | Water Supply Refuse Disposal | Construction and Engineering

DECEMBER, 1933

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December 1933

PUBLIC WORKS

Vol. 64 No. 12

CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

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TIME-WASTERS

Time-wasters we are dubbed by Bob Clark, who has just turned in a 5-page solution to the simple little problem (1) below. This is probably seconded heartily by Don T. Hastings, who shipped in four pages of solutions to the September and October problems. On the other hand, Professor Phelps disposed of the graduate problem in the October issue in a one-page typewritten letter. Wattaman!

The column in the November issue ran true to form in having a connection with some *problems*, but with the Kingfish still lost in the wilds of New Jersey and we leaving dull care behind with a journey back to dear old Alabama, there were no *time-wasters*. BUT NOW ! ! !

? ? ? ? ? ? ? ?

What three numbers are such that the sum of the squares of these numbers is equal to the square of the sum of the same numbers?—*B. E. Eisner.*

Another Day, Another Problem:

What number of three digits, when increased by one-third of its value, gives a number composed of the same three digits; and when this number is also increased by one-third of its value it also gives a number composed of the same three digits?—*R. N. Clark.*

Getting Easier:

Divide a square into 25 small squares, and in these place 25 consecutive odd numbers (3, 5, 7, 9, etc.) of such values and so arranged that the sum of each horizontal line, of each vertical column and of each diagonal shall be 175.—*A. P. Folwell.*

Looking Backward:

The problem (a) in the October issue has a whole lot of answers. We should have required only the smallest, says Don T. Hastings. This is 42857. With $x = 28$ and $y = 9$, we get the following cute little number: 551020408163265306122448979591. And there are others even worse. In the (b) problem, same issue, with $x = 16$ and $y = 3$, the number is 1348314606741573. And of course there may be any number of either x or y values.

A New Year Resolution:

We won't run any more of those long hard ones. That is, we won't do it till after New Year's, anyway. But, listen, we have a fine problem all ready for January. Be sure to ask Santa for a log book, pencils and lots of paper.

And wishing you a Merry Christmas and a Happy New Year—full of prosperity and hard work,

As ever,

W A H

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A. PRESCOTT FOLWELL, *Editor* W. A. HARDENBERGH, *Asso. Editor*

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PUBLIC WORKS

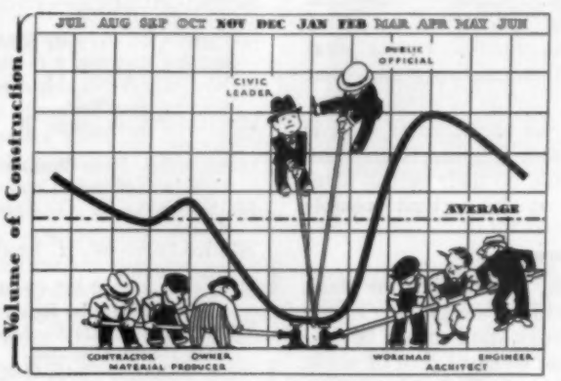
City, County and State Engineering and Construction

Vol. 64 — *December, 1933* — No. 12

Opportunities Offered by the CWA and PWA

"I want to ask that we forget some of the difficulties about this business and look for the opportunities to move ahead."—Harry L. Hopkins, Federal Emergency Relief Administrator.

APPLICATIONS for PWA funds are now greatly in excess of the remaining available money. Late reports indicate that applications now on hand aggregate nearly seven times as much as can be granted. In view of this, PUBLIC WORKS MAGAZINE has asked the Public Works Administration whether further applications will be received and what chance such worthy projects may have to secure grants and loans.



Courtesy Portland Cement Association

The question of receipt of further applications depends entirely upon the State PWA boards and engineers, and in all cases contact should be made with these. In some cases, it is doubtful if any applications will be received in addition to those now on hand. In case applications are no longer being received, it is suggested (by PUBLIC WORKS MAGAZINE) that the question be taken up direct with PWA headquarters in Washington and pressed vigorously. This is especially the case in those states where slow handling of applications has resulted in delay and in few grants.

It is stated by PWA headquarters in Washington that, in general, it will be the policy, in giving precedence to applications, to place equal emphasis on date of filing and desirability of the project. Due to the decentralization of power and responsibility and the more than exasperating slowness with which *some* state PWA engineers have been acting, it seems to the editors of this magazine that such a policy will be difficult to apply. We therefore recommend *immediate filing of applications*, pressure on those PWA state engineers who have been delinquent in passing on projects, and close contact with Washington. Considerable delay has been due to faulty applications. What these faults have been are described on page 22. Every effort should be made to avoid them in the future. It is possible that a perfect application made at the last hour might be given precedence over earlier ones which would need further revising.

Of course, many of the projects now on file will be disapproved, but time is growing short, and projects should be speeded up.

The Civil Works Administration

The purpose of the Civil Works Adminisctration is to put men at work on public works construction at regular wages at once. The projects on which men are to be employed must be (1) socially desirable and in the interests of the public welfare, and (2) of such nature that they may be quickly undertaken.

Types of work include flood control; low-cost road construction; water and sewer extensions; rural sanitation; drainage, as for mosquito control; repairs to public buildings or to water and sewage plants; filling over garbage dumps, highway maintenance, etc.

Payments to the men will be on the base PWA scale of 50 cents an hour for unskilled labor and up to $1.20 per hour for skilled labor. Men will work 30 hours a week. Payment for labor will be made direct to the men by CWA disbursing officers. Local communities will generally not be called on to pay any part of these wages. All will be paid by the CWA.

Materials to be used will generally be decided upon by the local engineer and will be paid for as decided in each individual case, and the same is true of equipment. Generally, while the CWA hopes that local communities can pay for these two items, as much as 15% to 20% of the total cost of the approved project may be spent for necessary materials and equipment from CWA funds. Such purchases must be approved by the local CWA.

Men will be obtained, about half and half, from those on the relief rolls and those registering through employment or reemployment offices of the U. S. Relief Administration. Those now registered for employment *should not* register for relief, as this will not expedite their being called to work. It is planned to place 4,000,000 men at work by December 15 and continue them until February 15, by which time Congress will have had time to act further.

Any state, county, city, town, or district can get CWA aid. States can get it for maintenance or low-cost highway construction, for rural sanitation and for mosquito eradication work. Counties for the same purposes. Cities and districts for the same purposes and in addition for sewage and water construction and improvements. Unincorporated areas should apply through the town or precinct in which they are located.

The CWA does not compete with the PWA and projects eligible for the one are not generally eligible for the other. *Projects on which applications to the PWA have been made cannot be withdrawn and entered under the CWA.* However, the PWA has created a special organization to go over projects filed with them and are referring certain of them to the CWA.

Making Applications

Applications for aid on Civil Works projects must be submitted by the responsible local officials to the local Civil Works Administrator in each county, who will submit the same, with his recommendations, to the state CWA. (A list of state CWA directors is published at the end of this article. Inquire of these men for the names and addresses of local CWA officials.) Applications must be on forms supplied by the local CWA. These are simple and require only data that are easily obtained.

The speed with which men can be placed at work is one of the most important factors. Engineers and municipal and county officials should do their best to place their quotas of men at work at the earliest possible moment.

Procedure

In preparing an application, the application blank provided by the local CWA will be the guide. In the absence of such application blanks, data should be prepared along the following lines: General plan of work, the man-days of work required; estimated cost; number of men that can be employed; hours of work; wages to be paid to the various classes of labor; expenses for materials and equipment; proportion of these to labor cost. A "brief" of the entire job should be given.

An important factor is the ability to complete the job, or such portion of it as may have been started, by February 15. Thus, a building only half completed by February 15 would be largely a total loss; but a storm sewer completely constructed over one-half of the desired length would have approximately 50% as much value as if completed.

Work on Private Property

Generally, work can not be done on private property unless it results in public welfare. Improvement of a privately owned park, open to the public, would not come under CWA regulations. The improvement of streams, owned privately, for the purpose of preventing mosquito production, and for flood control to prevent damage to public property, is permitted.

Such decisions are made primarily by the local CWA and confirmed by the state CWA.

STATE CIVIL WORKS ADMINISTRATIONS

ALABAMA—Thad Holt, Director, 1204 First National Bank Building, Montgomery.
ARIZONA—Miss Florence Warner, Exec. Sec'y, State Board of Public Works, Phoenix.
ARKANSAS—W. R. Dyess, Director, Old Post Office Building, Little Rock.
CALIFORNIA—R. C. Branion, Administrator, 611 State Building, San Francisco.
COLORADO—Official Colorado State Relief Commission, Equitable Building, Denver.
CONNECTICUT—Miss Eleanor H. Little, Exec. Dir., State Office Building, Hartford.
DELAWARE—Walter Dent Smith, Exec. Dir., Delaware Trust Building, Wilmington.
DISTRICT OF COLUMBIA—Melvin C. Hazen, Chair., District Building, Washington.
FLORIDA—Marcus Fagg, Director, P. O. Box 904, Tallahassee.
GEORGIA—Miss Gay B. Shepperson, Administrator, State Capitol—311, Atlanta.
IDAHO—Parker P. Carver, Administrator, State House, Boise.
ILLINOIS—Wilfred S. Reynolds, Exec. Sec'y, 10 S. La Salle Street, Chicago.
INDIANA—William H. Book, Exec. Dir., State House, Indianapolis.
IOWA—E. H. Mulock, Chairman, Old Federal Building, Des Moines.
KANSAS—John G. Stutz, Exec. Dir., 501 National Reserve Bldg., Topeka.
KENTUCKY—Thornton Wilcox, Director, 5th & Jefferson Streets, Louisville.
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MAINE—John A. McDonough, Administrator, State Capitol, Augusta.
MARYLAND—Harry Greenstein, Administrator, 407 Union Trust Building, Baltimore.
MASSACHUSETTS—Joseph Bartlett, Director, 15 Ashburton Place, Boston.
MICHIGAN—Fred R. Johnson, Director, 609 City National Building, Lansing.
MINNESOTA—F. M. Rarig, Jr., Secretary, State Office Building, St. Paul.
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MISSOURI—Hon. Wallace Crossley, Director, Madison Hotel Bldg., Jefferson City.
MONTANA—T. C. Spaulding, Director, State Capitol, Helena.
NEBRASKA—W. H. Smith, Chairman, State Capitol Building, Lincoln.
NEVADA—Cecil W. Creel, Secretary, Extension Dept., University of Nevada, Reno.
NEW HAMPSHIRE—Miss Eunice Edna Patch, Director, State House, Concord.
NEW JERSEY—John Colt, Director, 540 Broad, Newark.
NEW MEXICO—Miss Margaret Reeves, Director, Bureau of Child Welfare, Santa Fe.
NEW YORK—Frederick I. Daniels, Exec. Dir., 124 East 28th Street, New York City.
NORTH CAROLINA—Mrs. Thomas O'Berry, Administrator, Revenue Bldg., Room 415, Raleigh.
NORTH DAKOTA—John E. Williams, Exec. Sec'y, Bismarck.
OHIO—Major E. O. Braught, Executive Director, State House, Columbus.
OKLAHOMA—Carl Giles, Director, c/o Collector of Internal Revenue, Oklahoma City.
OREGON—Elmer R. Goudy, Executive Secretary, Spalding Building, Portland.
PENNSYLVANIA—Eric H. Biddle, Executive Director, State Office Building, Harrisburg.
RHODE ISLAND—George R. Cody, Exec. Sec'y, State Office Building, Providence.
SOUTH CAROLINA—Malcolm J. Miller, Administrator, National Bank Building, Columbia.
SOUTH DAKOTA—W. L. Eales, Administrator, State Capitol, Pierre.
TENNESSEE—C. C. Menzler, Admin., War Memorial Bldg., 420 6th Street, No. Nashville.
TEXAS—Col. Lawrence Westbrook, Executive Director, State Capitol, Austin.
UTAH—Robert H. Hinckley, Director, State Capitol, Salt Lake City.
VERMONT—Proctor H. Page, Chairman, State Capitol, Montpelier.
VIRGINIA—William N. Smith, Administrator, 11 South 12th Street, Richmond.
WASHINGTON—Charles F. Ernst, Director, Old Capitol Building, Olympia.
WEST VIRGINIA—Wm. N. Beehler, Deputy Administrator, State Capitol, Charleston.
WISCONSIN—Robert Johnson, Director, State Office Building, Madison.
WYOMING—F. M. Howard, Secretary & Auditor, State Capitol, Room 11, Cheyenne.

Cold Weather Construction of Concrete

MUNICIPAL work for the relief of unemployment to be effective must be carried on during the winter, when other jobs are scarce and suffering is most acute. Much of the work for which government money has been made available is built of concrete, and concrete requires protection from low temperatures if normal strengths are to be secured.

The hardening of concrete is a chemical change requiring moisture and a certain amount of heat. If either of these is absent the chemical change stops, or proceeds very slowly. Concrete hardens best at temperatures of from 60 to 80 degrees Fahrenheit. If mixing temperatures are above 100 degrees there is a definite falling off in strength, while at curing temperatures below 40 degrees the gain in strength is very slow. At freezing temperatures the moisture in the hardening mixture congeals, hydration of the cement particles is stopped and expansion of the freezing water breaks down the bond between the partly hydrated cement particles and may result in complete destruction of the concrete.

Tests indicate that concrete deposited at 70 degree temperatures and cured for 28 days at temperatures of 50 degrees have about three-fourths the strength of that cured at 70 degrees, while concrete cured at 33 degrees has only two-thirds normal strength.

This indicates that winter construction must be accompanied by some positive means for maintaining proper curing temperatures. The exact means selected depend upon the type of construction being done, but usually consist of heating one or more of the ingredients and enclosing the concrete so that this heat is retained.

Chemical Protection

Chemicals are sometimes used with the idea that they will protect concrete from damage by reducing the freezing point of water. Salt has sometimes been used for this purpose but is detrimental to concrete and is not recommended.

Calcium chloride also is sometimes used to lower the freezing point of the mixing water. One pound of this salt per gallon of water will lower the freezing point to +24 degrees F. and will, at the same time, usually result in more rapid hardening of the concrete. As more than 6 pounds of calcium chloride per sack of cement is liable to reduce concrete strengths somewhat, the amount above (assuming a 6 gallon water cement ratio) is about all that can be safely used. Obviously, this slight lowering of the freezing point is not sufficient to afford protection during very cold weather and some other means must be provided, even though calcium chloride is used. Also, not all cements react alike with calcium chloride; it is advisable to test the particular cement to be used, with the admixture, before proceeding with important work.

A board wall and a stove kept this concrete from freezing during December and January

Heating the Mixing Water

One of the simplest means of raising the temperature of concrete is to heat the mixing water. The specific heat of water is high, and any heat it has is therefore very effective in raising the temperature of the other ingredients, in spite of the comparatively small quantity of water in the mix.

Water is frequently heated in a coil installed in the line to the mixer. A long coil of closely spaced pipes absorbs the greatest percentage of available heat. The coil is made of water pipe of at least as great diameter as the balance of the pipe line and is heated by a fire built within it. If the mixer is not stationary, the coil is carried in a metal wagon.

Where steam is available it can be used to heat the water, either by installing steam pipes in a water tank or by discharging steam directly into such a tank.

Heating the Aggregate

Heating the water is effective for fairly mild temperatures only. For colder weather, when the aggregates themselves are frozen, heating of the aggregate must be resorted to.

This is most commonly done by piling one or both aggregates over metal culvert pipes in which fires are built. These are arranged so that unheated material can readily be piled over the pipes as heated aggregate is removed. As temperatures higher than about 350 degrees F. will cause some kinds of aggregate to flake

off or crack, the heat should be controlled so that this temperature is not exceeded even next to the culvert pipe.

Or, a pile of aggregate may be heated by a grillage of steam pipes that run through it. Such heating requires more time, but has many advantages.

Sometimes steam is discharged directly into the aggregate, either in a pile or in a proportioning bin. While this is fairly effective, it saturates the aggregate and makes it difficult to control the quantity of mixing water used.

Both aggregate and water are sometimes heated by an oil-burning torch after they get in the mixer drum. This is fairly satisfactory for mild weather but does not raise temperatures sufficiently for freezing weather unless the mixing time is prolonged unreasonably, which has the bad effect of reducing production as well as drying out the concrete before it is placed.

Cold Weather Construction of Pavement

Pavements are especially susceptible to low temperatures because they are built in thin sheets which are easily chilled and, at the same time, difficult to protect. The construction of pavement in freezing weather is, therefore, not recommended, unless there is urgent need for a particular short stretch of surfacing, and only then when protective equipment is ready in advance and every possible precaution is taken to prevent freezing of the concrete. When temperatures are not actually below freezing, however, concrete pavements can be built with reasonable safety.

The subgrade must be free from frost. It is easier to keep it from freezing than to thaw it out afterward, so before it has frozen it is brought to the correct elevation and then covered with 5 or 6 inches of hay or straw.

After the heated concrete has been placed and finished it is immediately covered with canvas, supported on frames which hold the canvas slightly above the concrete surface. In very cold weather steam pipes are run along both sides of the slab, under the canvas, and sufficient steam is kept in them to maintain a temperature of 70 or 80 degrees for at least three days. For milder weather, when daytime temperatures are well above freezing and the thermometer does not go below about +20 degrees at night, a 6 or 8-inch layer of evenly distributed straw, placed on the slab after the concrete has hardened enough to prevent marking, is sufficient protection. A piece of burlap or canvas stretched over the straw gives added protection.

The average paving specification requires that concrete shall be placed only when its temperature is between 50 and 100 degrees F.; that temperatures shall be maintained at not less than 40 degrees for 96 hours and that the pavement shall be protected from freezing until the concrete has a modulus of rupture of 500 lbs. per square inch.

Retaining Heat in Structures

Nearly all types of concrete structures can be built at low temperatures without danger and at only slightly greater cost than for warm weather construction. The forms alone afford some protection and it is easy to enclose bridges and buildings in canvas walls and heat them from within or, in the case of solid structures like piers, an enveloping canvas or plank wall can be constructed to hold a blanket of straw a foot or two thick around the pier. Such an enclosure has been known to keep a pier warm for days in below zero temperatures.

Braziers or salamanders burning charcoal, coke or coal are generally used to heat structures, though on the larger ones or where even a little smoke might do serious damage, boilers are sometimes set up and steam is piped to any part of the structure which might be menaced by frost.

In underground work, like sewers or for structures partly underground, like sewage disposal plants, protection is comparatively easy. There, a cover is built over the top and fires are maintained beneath.

The mortar used in masonry work is especially liable to be damaged by frost, principally because the masonry units themselves are cold and the layer of mortar is thin, so protecting canvas walls and artificial heat are necessary in freezing weather.

Artificial heat applied to concrete, either in heating the ingredients or in keeping the concrete warm after it is in place, tends to dry the concrete even more than the same temperature would in summer weather. For that reason it is even more important that heated concrete be kept moist during the curing period. It is especially important that the concrete adjacent to the heating unit be kept moist. In the case of a salamander set on a concrete floor, for example, the floor beneath and around the salamander should be covered with sand and this sand be kept constantly moist.

Low-Heat Cement for Dam Construction

Low-heat cement was developed and used for Pasadena's Pine Canyon dam. This gravity dam, 328 ft. maximum height and 277 feet maximum thickness, containing 436,000 cu. yd. of concrete, was constructed in 20 months. Mass concrete of such volume has a temperature above normal for years after it is placed, and, if bound to a solid rock foundation, the shrinkage causes tensile stresses and frequently cracks. The lower the temperature rise due to chemical action of hardening, the less these stresses. The heat of hardening can be reduced by reducing amount of cement used, or mixing with it finely ground silica, or using a large percentage of plums. The specifications for Pine Canyon dam, issued July 12, 1932, are believed to be the first in which a large quantity of cement was purchased with a provision specifically limiting the heat of hydration at 7 and 28 days. Tricalcium aluminate was limited to 6% maximum and 1% minimum. The residue on a standard 200-mesh sieve could not exceed 8% nor be less than 2%. The average compressive strength of cylindrical test pieces of 1:3 mortar 2″ diameter and 4″ long (A. S. T. M. standard) must be at least 800 lbs. per sq. in. in 7 days and 2000 lbs. in 28 days. The cumulative heat of hydration was limited to not to exceed 65 calories per gram of cement up to 7 days after mixing, and not to exceed 80 calories up to 28 days. (The cement used has averaged 53 to 56 calories at 7 days and 60 to 65 at 28 days.) Tests of 284,950 bbl. of this cement and use of same demonstrated that it is possible to predict, upon the basis of chemical analysis, the heat of hardening of all cements tested within 10 percent and generally much closer to the true values determined by heat of solution methods.

The highest temperature so far obtained at this dam is 107°F., which was reached in the center of mass where the dam is 210 ft. thick and the thermometer 50 ft. above foundations. The initial temperature of the concrete mix was 71° and the time required for the rise, three months. In the following three months the temperature fell 1°F. If ordinary cement had been used the temperature would probably have risen to 125°.

LEFT, *Surface replacement, using torches, in freezing weather.* RIGHT, *This street has broken in the same spots annually for five years. Now is a good time to fix it.*

There is every incentive to carry on road and street construction this winter on a scale never before known. The inhibitions against cold weather construction are a relic of past years, and there are no real reasons why first class results may not be obtained, if a relatively few simple precautions are observed. The engineers of America are perfectly competent to meet the situation, and with the Spring of 1934, we should find ourselves with much improved public works facilities, obtained at reasonable cost, together with a group of employed men, who have been putting energy and skill into building, instead of enforced idleness.

The Editors.

Winter Road Work Using Asphalt

By Bernard E. Gray

Engineer, Asphalt Institute

IMPROVED equipment and methods have made it little more difficult to construct durable roads and streets in winter than in warm weather, especially if operations are so planned for stage construction that the bulk operations are carried on in winter and the finishing operations deferred until spring.

The important first step is the plan, which should include a permanent remedy for bad foundation and drainage. For rural highways, a center line profile with 50-foot cross-section will suffice for planning and can be made at the rate of several miles per week by a party of three men at a total cost of not more than $100 a mile. A city engineer said, in reference to a street needing improvement: "I have worried with this street for years. I know every soft spot in it and where it breaks every spring. I can take my notebook and in two hours draw up all the plans and specifications necessary to make a real job, and I'll bet I won't miss the actual cost 5%." In other words, *work can start at once.*

Foundation

When there is alternate freezing and thawing, difficulty is often found in obtaining a proper fine grade. This is best accomplished by spreading an inch or two of fine aggregate, all passing a ¼ inch screen, which can be raked to a smooth finish almost regardless of temperature and is equivalent to an equal depth of coarser stone, so that 2 inches of the fine and 6 inches of coarse aggregate are satisfactory where a normal foundation thickness of 8 inches is required.

There may be some settlement during the spring following winter subgrade work, and a flexible foundation is therefore desirable. If surfacing this is deferred until spring, opportunity will be had to correct any such irregularities and produce a finished job with the best riding qualities.

For a surface treatment only, one of the best materials for cold or wet weather is a quick-setting emulsified asphalt. Sometimes a little warming is desirable, but in general this material can be used cold, and effective work done at 33°F. or above. It can be applied to a wet road surface, even when snow has just been removed, a broom drag being used on the cover aggregate to insure even distribution. If temperatures continue around 30° it may be desirable to drag the surface for several days, as the asphalt sets slowly under those conditions; but setting will eventually take place and manipulation meantime is accomplished more easily than with any other bituminous material under like conditions. When the temperature is 40°F. or above, the medium curing cutbacks may be applied as primer, with either hot or cold asphalt seal coats as alternates with emulsified asphalt. Where winter conditions are severe, moisture is usually sufficient to maintain the surface in such shape as to carry traffic under a "slow speed" restriction until such time as a prime treatment is possible.

For road work outside of towns, where traffic-bound operations are more feasible, there may be distinct advantages in winter work. In this, the aggregate (slag, stone or gravel) should be spread immediately after the subgrade has been prepared and bladed to a smooth surface. Where settlement occurs due to freezing and thawing, additional aggregate should be spread and dragged. During the winter, points of faulty drainage or bad subgrade that reveal themselves can be remedied, and when spring arrives the road will be in a more permanently stable condition than it would be after two or three years if constructed in warm, dry weather, offsetting the slightly greater first cost. Construction of such a base makes ideal win-

Winter Construction of Asphalt Pavements is entirely practical.

ter work. Work in pits and quarries can be begun at once, generally at widely scattered points, with a rate of production nearly as good as in summer; there is no danger to the base from freezing, and surfacing can be left entirely until spring if desired.

Stage Construction Surfacing

As an example of surfacing as a step in stage construction, work this winter in a New Jersey town may be noted. Many of its streets had been maintained by annually spreading additional crushed stone, watering and rolling. During the early years earth worked up into the stone, and at present, although completely stable, the surfaces are uneven. The town engineer could not obtain enough C W A money to lay high-type surfaces. He wanted to use as much labor as possible this winter, and take advantage of the present stability, and adopted the following procedure: Scarify the road to a depth of about 3 inches; shovel the loosened material to one side and screen it to recover all stone. Then cover the road with an inch of new screenings, drag and roll to a uniform cross-section and spread evenly on this the salvaged stone together with about 75 lbs. of new stone. Bind with screenings, water and roll to a firm surface. This removes the dirt from the upper surface, salvages the aggregate and produces a thoroughly keyed and bonded surface.

A surface treatment can then be added consisting of primer and seal coat of cutback asphalts MC-1 and RC-1, or emulsified asphalts; but in this case there is no object in delaying treatment until spring. Including this, the improvement will require only approximately 100 lbs. of new aggregate and ¾ gallon of asphalt per square yard, and all the rest of the money will go to labor and the operation of a small amount of equipment. Work can be carried on almost every day and traffic be but little inconvenienced.

Hot-Mix Construction

Hot-mix construction is a strictly feasible winter time proposition; there is nothing untried about it. All that is required is to operate with somewhat higher temperatures in the asphalt mixtures at the time of laying and finishing, in order to give a little more opportunity for manipulation.

There are two principal methods of procedure, one the surface-heater method, which may be used where pavements are reasonably intact, but thin after years of use; the other, a complete resurfacing where it is desirable to cover worn concrete or other types. Many hot-mix plants are available and could be started up in a few days' time and work put under way immediately. The surface heater also can be used to advantage on complete resurfacing work, especially in very cold weather. By heating the foundation just before placing the hot-mix top, the frost is removed and a good bond secured. Once compacted, no further precautions are required as there is no danger from freezing, no curing is required, and the pavement can be opened to traffic in a few hours.

In the surface-heater method, the old asphaltic surface is heated to the point where it becomes sufficiently softened to permit the removal of approximately one-half inch depth by raking, after which sufficient new asphalt hot-mix is deposited, raked and compacted to bring back the full depth of pavement. Usually this amounts to about one inch depth of new material, or about 105 lbs. per square yard. The method permits salvage of all foundation values, and lends itself particularly well to winter time work.

For complete resurfacing, the same procedure is followed as in summer time. Only one or two extra precautions are required in cold-weather operations, and may be most easily expressed in a simple table as shown in the Ohio specifications.

Plant Temperature °F			Road or Street Temperature °F		
Aggregate	Asphalt Cement	Mixture at Plant	Minimum	Ideal*	Maximum
300 to 375	250 to 350	275 to 375	275	325	375

This means that the temperatures at the plant should be raised to insure the "ideal" temperature on the road. Truck beds transporting mixtures should be properly insulated, and all covers fastened so as to keep out the wind. With these simple precautions as to handling materials, and by finishing the surface close behind the spreading and raking, good work can be done at temperatures as low as freezing.

Relaying Brick and Stone Block

Relaying of old brick and block pavements is another job that can be accomplished under winter conditions in a satisfactory manner. There are many miles of such

*In cold weather, ideal temperature should be increased 10%, or approximately to 360°F.

surfaces that have been allowed to get out of shape, and yet which are valuable from a salvage standpoint. The steps of procedure are, (1) remove old block or brick, (2) clean and reshape base, (3) place mastic cushion, (4) relay the brick, (5) roll to uniform cross section, (6) pour joints with asphalt filler.

The mastic cushion is a cold-mix, except that in very cold weather, slight warming is desirable to insure easy spreading. It is composed of clean, dry sand and asphaltic material with 92 to 95% of the former, mixed in a concrete or other approved batch mixer. It is spread on the prepared base to form a cushion with a completed depth of ¾ inch and shaped to a true surface by means of a templet extending the entire width of the roadway and sliding on the curbs or other guide rails; or if the road is too wide for this, temporary guide rails may be laid on the base. If use of templet is impracticable, the mastic cushion is shaped by hand lutes.

Such work fits in very well with colder weather conditions. In the early hours, the operations would include removal of old surface, cleaning of the brick or block, and shaping of the base, and then during the warmer period of the day the placing of mastic and relaying operations could be accomplished, with rolling carried on immediately following. In the later afternoon hours, removal of old surface and cleaning would be resumed.

Using Tar in Winter Road Work

By Geo. E. Martin

Consulting Engineer, General Tarvia Dept., The Barrett Co.

THE road builder and the bear have had one trait in common—they both hibernated in the winter. To be sure, some highway contractors have not gone in with a very heavy padding of fat in the past few years, but, nevertheless, they dug in for the winter. Now the highway bears are being driven out. Unemployment and the need for work relief is greatest during the winter season. Thus there is a demand for highway projects which can be carried on throughout the winter season.

Grading, drainage and the placing of aggregates such as gravel and stone can readily be carried on throughout the year, although these operations may be somewhat more costly in the winter. It is often assumed that work requiring the use of tar cannot be done except in summer weather. Such is not the case. Tar has been successfully applied during all the months of the year.

By selecting the best of the available days and modifying the methods of using the tar, excellent work can be done at a reasonable cost throughout the winter season.

Prime Coats

Prime coats for original treatments may be applied when the road is damp, but not wet. The lower range of viscosity, namely 8-13 specific viscosity at 40°C., should be used. The tar may be warmed to not more than 125°F. to facilitate application. The tar will penetrate into the road surface, although it may penetrate somewhat more slowly than in warm weather. For this reason a very light sand cover may be needed if the road is to be open to traffic.

Re-Treatments

Any of the cold surface treatment tars may be used when the road surface is clean and not actually wet. They may be heated to 125° to 150°F., depending upon their consistency.

The tar should not be left uncovered and therefore covering operations should follow immediately after the application of the tar. A tar cut-back material like "Tarvia KP" makes an excellent winter surface treatment tar. It should not be heated above 100°F.

In place of the hot surface treatment tars, such as "Tarvia A", better winter results will probably be obtained by the use of a heavy Re-Tread tar with a specific viscosity at 50°C. of 26 to 36. Here again, the cover-

Top, heating tools; other pictures show laying of tar mix in December, 1932. Northern New Jersey. Note Snow.

ing material should be spread as soon as the tar has been applied. Rolling will assist in setting the cover into the tar. This rolling should be accomplished as soon as the cover has been applied.

Re-Tread

Re-Tread construction can be carried on throughout the winter. The lighter grade of Re-Tread binder, with a specific viscosity at 50°C. of 16 to 22, should be used.

The tar can be applied when there is no free water on the surface of the stone. If necessary the stone can be dried by turning with a blade grader maintainer, or similar road machine, before applying the tar. This type of tar can be heated up to 175°F.

Penetration Macadam

The regular tar binder can be used for the penetration course and can be applied when there is no free water on the stone. The tar can be heated up to 275°F.

A hot surface treatment tar such as "Tarvia A" makes a better winter seal coat than the regular penetration tar.

Choke stone and cover stone should be applied while the tar is still warm, and rolling should follow immediately.

Tarvia-lithic

The use of tar-coated stone such as "Tarvia-lithic" can be readily carried on during the winter.

The tar-coated stone is prepared warm in the central mixing plant and trucked to the job for distances up to fifty miles. Canvas covers on the trucks retain some heat in the mixture and by the use of heated tools the material can readily be spread on the job. Here again rolling should be accomplished as soon as possible after the material has been spread.

Car shipments of tar-coated stone may be warmed by means of low-pressure steam applied through pipes, similar to well points, at various points in the car. Care must be taken to see that the pipes are not left in one place long enough to soften the tar coating on the stone. The object of the steaming is to warm the material sufficiently so that it can be readily handled.

Patching

Patching material may be made by mixing twelve to fourteen gallons of a tar cut-back such as "Tarvia KP" and suitable dry aggregate. The aggregate should be kept dry, if possible, until it is to be used. If wet aggregate must be used, it should be dried by heating before mixing with the tar. The tar-coated stone may be prepared on bad days and stored for use on good ones.

Holes to be patched should be clean. They may be damp but should not be wet. Rolling or tamping must be done as soon as the mixture has been placed.

Patches may also be made with "Tarvia-lithic" and in the same manner as the local tar cut-back mixture.

Hot penetration patches may also be made during the winter season.

Careful attention to a few details will produce satisfactory construction or maintenance work using tars throughout the entire year.

Chemical Treatment of Sewage

WE are sorry to learn that inaccuracies occurred in the abstract of Dr. Mohlman's paper on Chemical Treatment of Sewage, which we published last month. Since this abstract appeared we have received a copy of the complete paper, which is a more important contribution to the literature on chemical treatment even than the abstract would indicate. Dr.. Mohlman writes us, calling our attention to the following:

(1) In my paper I quoted 79 per cent reduction of the B.O.D. in the chlorinated effluent, in the tests of the Laughlin Process at Coney Island. This was not included in your Table II.

(2) In Table II, "Ashland" should follow "Travers," not "Stevenson."

(3) In Table I, "Kirnhurst" should be "Elmhurst."

(4) There was no statement in my paper that the Guggenheim Process "seems the most promising of all chemical precipitation processes." I carefully avoided any such distinction. I reported that the experimental results showed the highest percentage reduction of B.O.D. and suspended solids for the Guggenheim Process. I also stated that "The practical value and cost (of Zeolite filters) should be demonstrated on a larger scale."

(5) In my paper I stated that further data in more detail should be submitted by Stevenson to confirm the hopes of 95 per cent reduction of suspended solids and B.O.D.

There are a number of typographical errors in Table I but in most cases the correct term or formula will be known to your readers. In Table II the figures refer to percentage reductions, although there is no indication in the table to show what they mean.

With regard to the editorial on page 23, there was nothing in my paper about one process costing "considerably over $100 per million gallons" for operation. This must refer to Mr. Waring's discussion. I did not refer to costs. Of course, cost must be considered in reference to results obtainable, but that is another subject which would have to be considered in considerable detail, and in my brief paper it could not be discussed fairly. In all treatment processes under consideration, there are two major considerations—(1) degree of treatment (or efficiency) and (2) costs. I dealt only with the former.

The last statement in the editorial that "reliance on bacteria for sewage disposal is being replaced by more direct, controllable and rapid chemical and physical treatments" is of course the opinion of the writer of the editorial, and not based on my paper.

I am sorry to write at this length, but in view of the interest in chemical treatment I think papers on the subject should be quoted correctly. Mr. Mendelsohn had very little time to abstract my paper and on the whole the abstract is correct.

Very truly yours,

(Signed) F. W. Mohlman

Certain remarks should have been added to table II (which tabulates information given in general descriptions of the several processes). In the Laughlin Coney Island tests, "chlorination at the rate of 62 lb. per million gallons increased the suspended solids reduction to 92% and the B.O.D. reduction to 79%." The Lewis figures were from "operation at Atlanta for 7 days at maximum efficiency." Travers' tests were made "recently at Ashland, O., over a period of 12 days." Stevenson stated that "experiments at Palo Alto indicated that it will be possible" to obtain the results given; "further data in more detail should be submitted to confirm these hopes." Of the Landreth process he says: "little information of authoritative character is available concerning the removals of B.O.D. and suspended solids" at Winston Salem. Of Cabrera's claims "no detailed results have been published."

Item (7) in the second paragraph of the abstract was derived from the statement in the paper: "The cost of incineration of chemically precipitated sludge per million gallons of sewage or per capita will probably be greater than that of fresh or digested sludge, because of the excess weight of precipitated solids and the low B.t.u. content."

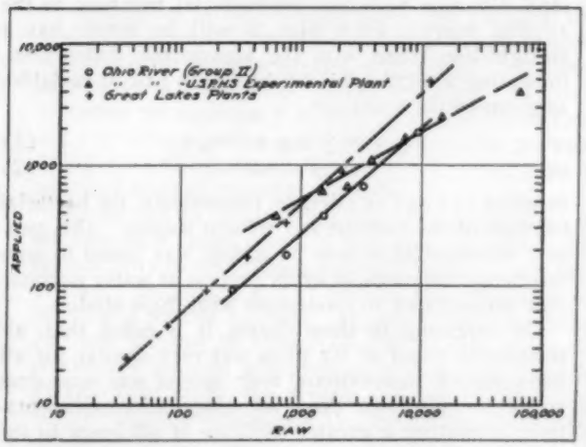


FIGURE 1. *Relation between 37° C. bacterial counts in raw and applied waters.*

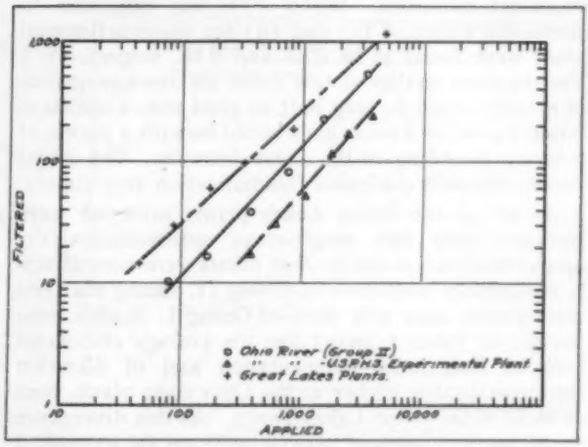


FIGURE 2. *Relation between 37° C. bacterial counts in applied and filtered waters.*

The Bacterial Efficiency of Certain Intermediate Stages of Water Treatment

By H. W. Streeter
Sanitary Engineer, U. S. Public Health Service

THE two previous articles * of this series have dealt with some special observations on chlorination and excess-lime treatment which were made in connection with the operation of an experimental water filtration plant by the U. S. Public Health Service at its Stream Pollution Investigations laboratory at Cincinnati. In the present article the results of observations made on the efficiency and limitations of certain intermediate stages of water treatment will be described. These results have been obtained both from the operation of the experimental plant, with the Ohio river as the source of raw water supply, and from two series of field observations of the efficiency of municipal water purification systems, embracing 10 plants located on the Ohio river and 14 plants located along the Great Lakes. Data received from 7 additional plants having river sources of raw water have not been included in the study on which this article is based, as the performance of these plants was very similar to that of the 10 Ohio river plants.

The municipal filtration plants included in the field surveys, as well as the experimental plant at Cincinnati, were of the ordinary rapid-sand type, with the usual three main stages of treatment, namely, coagulation-sedimentation, rapid-sand filtration and post-filter chlorination. Five of the 10 Ohio river plants, designated hereafter as Group I., were equipped, however, with two separate stages of preliminary sedimentation. The remaining 5 Ohio river plants, designated as Group II., carried the more usual single-stage sedimentation. At two of the plants of Group I., a coagulant was added at each one of the two stages of preliminary sedimentation. At the other three, the primary stage consisted of plain sedimentation, for a relatively long period, and the secondary stage of ordinary coagulation-sedimentation. The experimental plant was equipped for double-stage sedimentation, with coagulation at either or both of these stages, but was usually operated with a single stage of 6 hours duration.

In section A of Table I., are given average figures based on results covering one year, showing the percentages of influent water turbidity and bacteria removed by various stages of treatment, as observed at the two groups of Ohio river plants, both separately and combined, and at the 14 Great Lakes plants. In section B of the same table are given the corresponding percentages of influent water turbidity and bacteria remaining in the effluent from each stage of treatment. (By the term "influent" is meant the water flowing to each stage, considered individually.) The figures given thus represent the relative efficiency of each stage as a separate unit of treatment. The "percentage remaining" figures are given in order to show more clearly minor differences in the efficiency.

On comparing the bacterial efficiencies of the three stages of treatment, it will be noted that, except for the Ohio river plants of Group I., which were equipped with double-stage sedimentation, the efficiency of each individual stage of treatment tended to increase measurably at each successive stage, being highest at final chlorination. For the plants of Group I., the superior efficiency of longer period double-stage sedimentation was clearly manifest in the higher percentages of bacterial removal recorded for this group, as compared with those observed at the plants of the other two groups.

From data obtained at the experimental plant at Cincinnati, it was suggested that the higher bacterial efficiency of double-stage sedimentation was due more largely to the longer total periods of sedimentation provided for this treatment than to any inherent advantage of separating this process into two separate stages.† These data indicated that the relation between the bacterial quality of the raw water and the corresponding quality of the effluent resulting from coagulation-sedimentation was influenced by the period of sedimentation according to the relation:

$$E_s = \frac{cR^n}{\log T}$$

in which (R) denotes the bacterial content of the raw water, (E_s) that of the coagulated-settled effluent, (T) the total period of sedimentation and (c) and (n)

*See Public Works, July, 1933, pp. 19-21 and August, 1933, pp. 17-19.

†See appended reference (7), Reprint 1392, pp. 16-22.

empirical constants. When (T) was expressed in hours, the values of (c) and (n) for the experimental plant were found to be 0.57 and 0.88, respectively.§ For the same quality of raw water the average quality of effluent would be only half as good with a sedimentation period of 3 hours as it would be with a period of 9 hours, according to the above formula. The actual results obtained confirmed this indication very closely.

As all of the Great Lakes plants surveyed were equipped only with single-stage sedimentation, the mean efficiencies shown at these plants were more directly comparable with those of Group II, among the Ohio river plants, than with those of Group I. Such a comparison in Table I. shows that the average efficiencies both of coagulation-sedimentation and of filtration were measurably higher at the Ohio river plants than at those of the Great Lakes group. As this divergence could not be explained satisfactorily on the ground of known physical differences in the two waters, such as turbidity, it was concluded that it must be due very largely to some chemical variance, manifested by the higher pH value of Great Lakes water, which would influence their relative susceptibilities to efficient coagulation.* If, as indicated, Great Lakes water were more difficult to coagulate effectively than Ohio river water, this difference conceivably might affect not only the efficiency of coagulation-sedimentation, but also that of filtration.

Because of marked divergences between the density of pollution of Ohio river water and that of Great Lakes water at various points, the average observed efficiencies of particular stages of treatment at the two groups of filtration plants were comparable only in a general way, as these studies have indicated that the efficiency of certain stages of water treatment, notably of those involving sedimentation, is influenced very decidedly by the degree of bacterial pollution of the influent water. A more definite basis of comparison is illustrated in Figures 1 and 2, in which logarithmic plots are shown of the relationships observed between the numbers of bacteria present in the raw and applied waters (the latter representing the product of coagulation-sedimentation) and in the applied and filtered waters, at the Ohio river plants, at the Great Lakes plants and at the experimental plant, respectively.† The relationships illustrated in Figure 1 indicate the relative efficiencies of coagulation-sedimentation with various bacterial numbers in the raw water and those in Figure 2, the corresponding efficiencies of rapid-sand filtration with various bacterial numbers in the applied water. Each plot, it will be noted, has a straight-line trend with the logarithmic scales used, indicating a relationship between each pair of variables as given by the equation:

$$\log y = n \log x + \log c \quad (1)$$

or

$$y = cx^n \quad (2)$$

in which (x) and (y) denote, respectively, the bacterial contents of the influent and effluent waters. This general relationship, it may be added, was found to govern the performance of every process of water purification investigated in connection with these studies.

On referring to these charts, it is noted that, although the trend of the plots was very similar for all three sets of observations, their spread was somewhat wider for filtration than for coagulation-sedimentation, indicating a greater variance of efficiency in the first case than in the second. The higher efficiency of both stages of treatment at the Ohio river plants, as compared with those observed at the Great Lakes plants, is shown by the lower effluent counts throughout the same range of influent counts. The higher filtration efficiency at the experimental plant as compared with that observed at both groups of municipal plants, appears to be due to the somewhat more favorable conditions under which the experimental filters were operated and possibly also to the slightly lower effective size of the sand in these filters, which was 0.40 mm. as against an average of 0.44 at the municipal plants.

In Figure 3 is shown a plot of the relationships observed between the bacterial content of the filter effluent and that of the chlorinated effluent. In this instance the trend of the three series of observations was so close that it has been indicated merely by a band, rather than by lines connecting the various points.

From the plots shown in Figures 1, 2 and 3, together with similar plots based on the corresponding B. coli data, values of (c) and (n) in the relationship $y = cx^n$, have been determined for various stages of treatment and for each of the three series of observations. By combining the most representative data obtained from the three series, values of (c) and (n) indicating the average performance of each stage of treatment have been derived. These values are as follows:

	37°C Bacterial Count		B. coli Index	
	(c)	(n)	(c)	(n)
(1) Plain Sedimentation	1.50	0.79	1.00	0.90
(2) Coagulation-sedimentation	0.73	0.90	1.40	0.83
(3) Filtration	0.66	1.12	0.15	0.82
(4) Chlorination	0.42	0.63	0.10	0.68
(5) Filtration-chlorination*	0.0085	0.84	0.0051	0.76

*Combined.

§See reference (7), Reprint 1392, p. 9

*See reference 2, Appendix B.

†For a description of the statistical methods followed in deriving these relationships, see appended reference (1), pages 18-19.

Table No. 1

Mean percentages of influent water turbidity and bacterial numbers removed by and remaining in effluent of each separate stage of treatment; as observed at municipal filtration plants along the Ohio River and the Great Lakes.

	Turbidity	Bact. Count, 48 Hrs. 20°C.			Bact. Count, 24 Hrs. 37°C.			B. coli Index		
	Coag.-Sed.	Coag.-Sed.	Filt'n	Chlor'n	Coag.-Sed.	Filt'n	Chlor'n	Coag.-Sed.	Filt'n	Chlor'n
A. Percent Removed										
Ohio R. combined	91.1	89.2	61.7	81.2	86.2	85.3	89.7	86.1	97.2	90.0
Ohio R. Group I.*	90.8	95.8	80.1	69.2	94.1	86.2	79.3	97.8	99.7	90.0
Ohio R. Group II.*	92.7	....	....	....	81.8	87.3	90.2	75.8	98.1	91.6
Great Lakes	65.1	50.6	70.0	94.8	59.0	66.8	87.3	62.7	87.5	93.2
B. Percent Remaining										
Ohio R. combined	8.9	10.8	38.3	18.8	13.8	14.7	10.3	13.9	2.8	10.0
Ohio R. Group I.*	9.2	4.2	19.9	30.8	5.9	13.8	20.7	2.2	0.3	10.0
Ohio R. Group II.*	7.3	....	....	....	18.2	12.7	9.8	24.2	1.9	8.4
Great Lakes	34.9	49.4	30.0	5.2	41.0	33.2	12.7	37.3	12.5	6.8

*Group I. = plants with double-stage sedimentation.
Group II. = plants with single-stage sedimentation.

By substituting the proper values of (c) and (n) in the general formulas above stated, the bacterial content of a given effluent corresponding to any assumed content in the influent water can be readily calculated, or vice versa. The most convenient way to do this is to reduce the equation $y = cx^n$ to its logarithmic form, $\log y = n \log x + \log c$, and then to calculate the value of log y, or of log x, and thence of (y) or (x) from an assumed value of the other variable.

As an aid in interpreting the numerical values of the constants above given, it may be noted that if (n) equals unity in the relation $y = cx^n$, then (y) will vary in direct proportion to (x) and the percentage of removal will remain constant. If (n) be less than unity, (x) will increase in proportion less than (y) and the percentage removal will increase with (x). If (n) be greater than unity, the reverse will hold. The value of (c) indicates the ratio of (y) to (x) when the latter equals unity.

From this standpoint it will be noted that in every case except one the value of (n) was less than unity, indicating a progressive increase in the efficiency of bacterial removal by each stage of treatment with greater densities of bacteria in the influent water. The single exception was that of (n) based on the 37° C. bacterial counts at the filtration stage, which value slightly exceeded unity. In this single instance the reversal of the more usual trend of efficiency appeared to be due very largely to the fact that the higher ranges of 37° C. bacterial counts were observed during the summer season, when the indicated efficiency of removal of this class of bacteria by filtration was measurably lower than during the colder season. That this tendency did not affect the corresponding efficiency of B. coli removal is shown by the lower value of (n), 0.82, for this group of bacteria.

In connection with this study it was desired to calculate the maximum numbers of B. coli in the influent water flowing to each successive stage of treatment which would yield a final chlorinated effluent conforming to the primary requirement of the Treasury Department standard; that is, having a B. coli index not exceeding 1.0 per 100 c.c., or a "most probable number" (M.P.N.) not exceeding 1.05 per 100 c.c. In the first case $y = 1$ and $\log y = 0$, whence

$$\log x = \frac{\log c}{n}$$

In a previous report* it has been shown that for ordinary rapid-sand filtration treatment, with single-stage sedimentation and prechlorination, the maximum raw water B. coli index corresponding to an index of 1.0 per 100 c.c. in the chlorinated effluent was about 6000 per 100 c.c., in round numbers. In another report† it has been shown that, when expressed in terms of "most probable numbers" of B. coli, this maximum approximated 9,000 per 100 c.c. From an analysis of the experimental B. coli data reduced to terms of "most probable numbers," the following values of (c) and (n) were obtained for filtration-chlorination and chlorination alone:

	(c)	(n)
(6) Filtration-Chlorination	0.000029	1.32
(7) Chlorination	0.0072	1.40

*See appended reference (9).
†See appended reference (6).

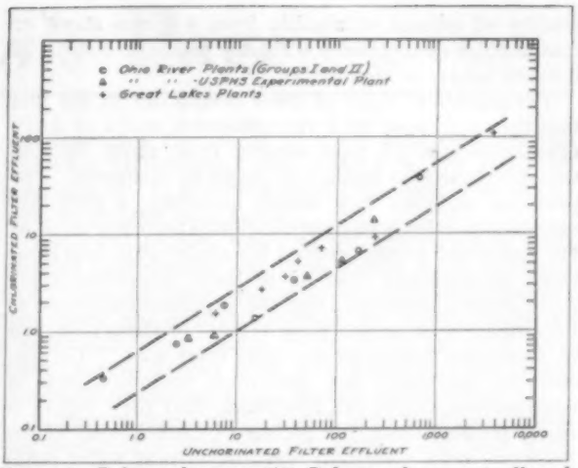


Figure 3. Relation between 37° C. bacterial counts in filtered and chlorinated waters.

In this case it will be noted that the values of (n) obtained exceeded unity, indicating that the "most probable numbers" of B. coli increased in the effluent in greater proportion than the corresponding increase in the influent. This is due, however, to the fact that in the lower densities of B. coli, as for example between 1 and 10 per 100 c.c., the most probable numbers increase disproportionately to their equivalent numbers when expressed in terms of the ordinary index, whereas in the higher densities their increase is very nearly in direct proportion.

By selecting proper values of (c) and (n) from those above given, it was calculated that in order to deliver a final chlorinated effluent having a B. coli index not exceeding 1.0 per 100 c.c., or an equivalent M.P.N. not exceeding 1.05, each water named below would have the following limiting average numbers of B. coli, expressed in terms of the ordinary index and of the "most probable numbers":

Limiting B. coli per 100 c.c.

	Index	*M.P.N.*
Raw	6000	9000
Applied	1700	3700
Filtered	30	35

From these figures it is indicated that, in order to produce a chlorinated effluent meeting the above standard of quality, the water applied to rapid-sand filters should have B. coli numbers not exceeding an index of 1700, or a M.P.N. of 3700 per 100 c.c. and the unchlorinated filter effluent should have corresponding numbers not exceeding 30 and 35, respectively. For the raw water, the maxima would be 6000 and 9000, respectively, as previously stated.

As these limiting figures have been derived from combined experimental and municipal plant data, they represent average conditions and hence are not strictly applicable to the performance of individual plants varying widely from the mean in this respect. For the average plant, however, they afford a rough criterion as to the limiting bacterial content of influent water at different stages of treatment which should permit the delivery of a final chlorinated effluent meeting the primary requirement of the Treasury Department standard with respect to B. coli content. Similarly, the values of (c) and (n) which have been given may be utilized to give an approximate estimate of the average

quality of effluent obtainable from a given stage or combination of treatment with any assumed quality of influent water, or vice versa.

The statistical value of these results lies in the fact that they are based on a very extensive series of daily observations, which have ranged from about 5000 to over 8000 for each individual stage of treatment. For practical purposes they afford, moreover, a very fair sample of current water purification experience, as all of the municipal plants selected for study were representative of problems common to their respective areas and the data obtained from the experimental plant at Cincinnati were shown to be typical of those observed at municipal plants in the Ohio river zone. The results of the study are presented, therefore, with a considerable degree of confidence that they reflect a fairly reliable composite picture of the efficiency of the processes more commonly used in current water purification systems throughout the Mississippi basin and along the Great Lakes. From comparisons of these results with those reported from other sections of the country, it is the writer's belief that they are applicable, in a broad sense, to rapid-sand filtration processes in general over an area much wider than that embraced by these studies.

For the benefit of those who may be interested in previous reports of the water purification studies from which the data presented in this article have been derived, a list of references to these reports is appended hereto. In this connection attention is particularly invited to references numbered (1), (2), (5), (6) and (9), for information bearing more directly on this article.

Grateful acknowledgment is made of assistance by C. T. Wright of the Stream Pollution Investigations laboratory staff, in preparing tracings of the charts presented in connection with this and the previous articles of this series.

References to Published Reports on Studies of Water Purification Efficiency

*Made by the U. S. Public Health Service.**

(1) Studies of the efficiency of water purification processes.
I. Results obtained from a preliminary study of the Cincinnati and Louisville municipal filtration plants.
II. and III. Results obtained from a collective survey of seventeen municipal filtration plants.
Public Health Bulletin 172 (1927).

(2) Studies of the efficiency of water purification processes.
IV. Report on a collective survey of the efficiency of a selected group of municipal water purification plants located along the Great Lakes.
Public Health Bulletin 193 (1930.)

(3) The loading of filtration plants. Public Health Reports, May. 31, 1922. pp. 741-753. (Reprint 737).

(4) Some preliminary observations from a study of water filtration plants along the Ohio River. Public Health Reports.
Jan. 30, 1925, pp. 202-213. (Reprint 987).

(5) Experimental studies of water purification. I. Description of experimental water-purification plant. II. Preliminary review of results of primary experiments. Public Health Reports, Oct. 1, 1926, pp. 2121-2146. (Reprint 1114.)

(6) Experimental studies of water purification. III. Discussion of B. coli results obtained from primary experiments.
Public Health Reports, July 15, 1927, pp. 1841-1859. (Reprint 1170).

(7) Experimental studies of water purification. IV. Observations on the effects of certain modifications in coagulation-sedimentation on the bacterial efficiency of preliminary water treatment in connection with rapid-sand filtration. Public Health Reports, July 4, 1930, pp. 1521-1536 and July 11, 1930, pp. 1597-1623. (Reprint 1392.)

(8) Experimental studies of water purification. V. Prechlorination in relation to the efficiency of water filtration processes. Public Health Reports, Dec. 19, 1930, pp. 3105-3128. (Reprint 1434.)

(9) Experimental studies of water purification. VI. General summary and conclusions. Public Health Reports, Apr. 14, 1933, pp. 377-400. (Reprint 1565.)

(10) Bacterial changes in chlorinated filter effluents.
Public Works, July, 1933, pp. 19-21.

(11) The bacterial efficiency of the excess-lime method of water purification. Public Works, August, 1933, pp. 17-19.

*Copies of Nos. (1) to (9), inclusive, may be obtained from the Surgeon General, U.S. Public Health Service, or from the Superintendent of Documents; both at Washington, D. C.

Heating Sludge Beds

At the Aldershot, England, sewage works, treating purely domestic sewage, J. W. Edwards, the manager, had experienced difficulty in drying sludge from sedimentation tanks containing about 94% moisture. In September, at a meeting of the Institute of Sewage Purification, he described experiments in heating a sludge bed to hasten the drying. A bed 84 by 24 ft. was used and sludge discharged onto it to a depth of 16 in. "The sludge was lightly raked over the second day for the purpose of breaking up the film that formed on the top of the filter media. When this operation was carried out, it was found that the sludge parted with its water freely as it poured away, and on testing it was found that the sludge had reached a temperature of from 70 deg. to 75 deg. in this period, and it was at this temperature that the sludge appeared to part with its water content. The sludge on occasions, wholly depending on its consistency, might require raking over again, but it seldom did. The sludge was left on the surface of the bed and continued to part with its moisture and was dried out and on the average on the seventh day was ready for removal."

The dried sludge contained between 50 and 60 per cent water—sometimes as low as 45 per cent. The steam used for heating the bed was very low, about five gallons of condensed water per hour leaving the trap.

A recent analysis of the sludge gave: grease—4.7%; volatile matter—20.1%; non-volatile matter—10.3%; moisture—64.9%.

Mr. Edwards stated that he expected to experiment with a greenhouse boiler to ascertain the minimum amount of independent heat required for heating a bed for optimum drying procedure.

Percolating Filter Media

He also made a comparative test of gravel, metallurgical coke and clinker as media for a percolating filter. The purification effected was about 70% with clinker or coke and only 58% with gravel. If gravel was used for the bottom of the bed, he advocated using clinker of about 1-in. gauge for the top 12 to 15 in.

He found that 28% purification took place in the top 4 in., 16% in the next 5 in., 7% in the next 3 in., 5% in the next 3 in., 5% in the next 12 in., 9% in the next 16 in., and 5% in the bottom 16 in.

Sanitation Work Under the Civil Works Plan

In connection with the plans for employment under the Civil Works Administration, more than 60,000 men will be engaged on rural sanitation and malaria control, mainly in the south. This work will be carried on through the state departments of health and the U. S. Public Health Service. In addition to the relief through labor, the direction of this work will require several hundred men skilled in sanitation and sanitary engineering.

The work will consist chiefly of the following: Mosquito control through drainage; privy construction; improvements to sewage treatment plants and to water works; rat control, and municipal sanitation, which includes cleaning alleys and streets, instituting city-wide clean-ups, collecting trash and junk and repairing refuse disposal facilities or improving them.

The Editor's Page

"There Must Be No Starvation of the Equipment Industry"

"In the conduct of contract work we must steer a safe course between machine and hand methods. In the effort to provide increased employment on the highways there must be no destruction or starvation of the equipment industry or loss of industrial employment that should be generated by such a widespread road building program.

"The higher-type work on the Federal aid system and on the municipal projects must be done with the essential equipment, while a large opportunity is offered for the use of hand labor methods on the secondary or feeder road projects."

So said Thomas H. MacDonald, chief of the Bureau of Public Roads, before the convention of the Association of State Highway Officials. And the words and ideas should be repeated emphatically until everyone is disabused of the idea that equipment (other than hand tools) is taboo in the recovery program.

Two arguments for the "all hand work" propaganda have been too widely and unthinkingly accepted: That if equipment is used there will not be enough work for all the unemployed, and that money spent for equipment is not helping to solve the unemployment problem.

The answer to the former is definite and decisive. So many and extensive public work projects already have been presented for Federal approval that the cost would total several times the billions of dollars available, and their construction would keep all the unemployed of the country at work for a year or more with full pre-depression use of equipment; and several times as much additional beneficial work undoubtedly is known to public officials.

As to the second argument, why is it more helpful to take unemployed mechanics miles from their homes to labor uneconomically with picks and shovels, rather than give them employment of the kind in which they are proficient, making equipment which will give several times as much return in work accomplished per dollar spent as could be obtained from the most energetic hand labor? Money spent in doing work in the most efficient way with adequate equipment not only gives much more return to the taxpayer, but goes just as completely to the relief of unemployment as though paid entirely for hand labor on the job itself. The only part not paid in *wages* is the profit of the contractor in one case, and a similar amount divided between contractor and manufacturer in the other, leaving the same amount in each case to be paid as wages.

Moreover, unequipped labor is but a partial improvement on the dole, for a large part of the money spent brings little return to the city or state spending it, and the laborers are conscious that the work they are doing is, in a way, "made work," which is bad for their morale. Again, consideration should be given to the fact stated by Mr. MacDonald, that *higher-type work cannot be performed properly without essential equipment.*

Can We Judge the Future?

Twenty years or so ago, when the automobile factories first began the wholesale use of labor-saving machinery, there was a cry, so familiar to us these days, against the use of so much machinery. It was technological unemployment coming to our notice on a large scale. If machines did all the work, what would men do to earn their bread?

What did happen was that the production of automobiles economically put them within reach of nearly every one. As more and more automobiles came into use, there was a great demand for better roads. In the construction of these better roads, far more men were employed than were ever discharged to be replaced by machinery in automobile construction.

A short-sighted policy would have kept men building motor cars by hand; few would have been sold, because of their high price. There would have been no real demand for good roads. The millions of men who have earned a living in building roads and manufacturing the equipment for highway construction—what of them?

If men are willing to go ahead constructively, to progress intelligently, they will find, perhaps not the pot of gold at the end of the rainbow, but certainly and surely better ways of living for all.

Designing Roads for Traffic Conditions

Announcement by the Portland Cement Association of methods for designing road slabs to meet the traffic conditions that these roads will be called on to bear is another sign of progress in highway engineering. As a result, secondary highways and residential streets can be paved with concrete at a cost less than formerly.

This announcement brings again to the fore a question which has long agitated engineers engaged in constructing and maintaining low-cost roads. What about heavy trucks? Most types of low-cost highways will not withstand heavy truck traffic; at certain periods of the year the passage of one heavily loaded truck may break down the road surface and necessitate repairs costing hundreds, if not thousands, of dollars.

Little has been said or written about this, yet some decision will have to be made sooner or later. Just now one group of engineers believes that provision must be made for heavy traffic on all roads, while another feels that regulation of truck weights is the answer. On the one hand, there will be the need for heavier and more costly construction; on the other, the necessity for barring the larger trucks from many miles of roads—often from those roads where the need for economical transportation is great, even though the volume of traffic is small.

We should be glad to hear from our readers about this.

Our Wishes for 1934

As we write this last item for the last issue of 1933, the new year is less than four weeks away. To our readers and to all engineers, we wish a Merry Christmas and a Happy and a Prosperous New Year. May the stern and grim recollections of the past year be buried deep in worthwhile activity; may the many who have been without work so long, find in 1934 full and satisfactory opportunities and employment.

Why Awards of PWA Funds Are Delayed

IN ANSWERING our request for suggestions how awards of PWA funds can be expedited, most of the PWA State Engineers report that many applicants for these funds failed to follow the instructions in Circular No. 2, which has caused considerable delay. Said Cornelius C. Vermeule, Jr. (New Jersey): "'Please give me the money, and details of how it is to be spent will be considered after we get it' is a blunt way of summarizing the usual application." Stanley H. Wright (North Carolina) said: "Many applications we receive are submitted carelessly and at times without regard for the essential facts. . . . A loan is requested upon a project that exists only in the mind of the applicant." "Only a small proportion of the applications give all the required information. This results in unnecessary correspondence and delay," says Arthur S. Tuttle (New York). Charles H. Fleming (Delaware) and Harold J. Lockwood (New Hampshire and Vermont) are the only ones who did not report delays due to this cause.

Specifying the delinquencies more in detail, the Washington headquarters report: Failure to include (1) statement of municipality's population for 1910, 1920 and 1930, explaining any abnormal changes, (2) schedule showing dates when funds will be needed and the amounts. Lack of drawings or other data sufficient for a thorough understanding of the work. Estimates of total cost are not subdivided in enough detail to permit accurate checking. When loans are to be secured by revenues from the project, estimates of annual income, operating expenses, etc., are not supported with adequate data. Under financial information, failure to give (1) assessed valuation of taxable property for last three fiscal years; (2) outstanding financial obligations, defaults and other facts as to local taxes; (3) evidence that ordinary current expenses are within prudently estimated ordinary revenues, or will be. Legal memorandum does not cover provisions of general, special or local laws empowering applicant to construct and finance the project.

Hugh Miller (Missouri) finds not enough time spent in preliminary investigation; engineers slight their work, and seek too many of these jobs with insufficient staff; labor and material costs are not separated in the estimates, quantities and unit prices not given in sufficient detail, and insurance cost and contractors' profit are omitted. Copies of ordinances authorizing application are omitted, and statement of how additional cost will be met if grant only is requested. All information and data should be in quadruplicate. Necessity for neatness in presenting information is emphasized by J. Houstoun Johnston (Georgia).

Wm. N. Carey (Minnesota) found the most notable deficiencies in the engineering data—insufficient general information and drawings not amplified by a report, and unitemized estimates.

On the other hand, M. E. Cooley (Michigan) finds "Engineering as a rule is fairly well taken care of," the chief deficiencies being financial and legal.

R. J. Paulette (Kansas) found incomplete financial data and lack of detail in estimates, but later applications much improved over earlier ones.

Arthur S. Tuttle (New York) cites failure of authorized official to sign application and of counsel to sign legal data; failure to allow, in the estimate, for effect of PWA requirements as to wages, hours, labor preferences, etc.; to give facts concerning balancing of budget; to secure necessary approval of work by state department (Department of Health for sewers, etc.).

J. A. Anderson (Virginia) found that, though the designs of small sewerage and waterworks systems were satisfactory, evidence that they could be made self-liquidating was not presented. But the greatest delay is in the "reluctance of municipalities to submit projects in the face of uncertain wage rates, which have been set higher than they ever have been in these localities."

Mr. Johnston finds in Georgia the principal difficulty has been misinformation in regard to type of security required. "The requirement that legal, valid security must be offered for loans should be given as wide publicity as possible."

Abel Wolman (Maryland) finds many of the above deficiencies—insufficient estimates not based on PWA wages and hours, with plans not sufficiently complete to permit checking estimates, inadequate figures concerning tax collections, bonds, etc., and legal details incomplete.

M. L. O'Neale (West Virginia) said: "We have been hedged about by so many laws that even the best attorneys have not always been in agreement as to interpretations."

Bids for Work With and Without PWA Requirements

Bids received October 30th by the Water Commissioners of Macon, Ga., for extension of Filter and Pumping Equipment. (Reported by J. Houston Johnston, State Engineer)

For new roof, steel window frames and other building work:	*With PWA Requirements*	*Without PWA Requirements*	*Percent Difference*
Lowest bidder	$23,932.90	$22,881.90	4.4
Average of all bids	28,709.86	27,138.63	5.5
For filter work, pipe fittings, etc.:			
Lowest bidder	37,844.00	36,344.00	4.0
Average of the 2 bids	39,182.00	37,882.00	3.3
Steam turbine driven 2-stage centrifugal pump, completely installed:			
Lowest bidder	62,272.00	60,722.00	2.5
Average of the 2 bids	65,736.00	64,061.00	2.5

Allowing for the 30% grant, the city profited 26.7 percent of the cost by contracting the work under the PWA plan.

Bids received October 23rd by the city of Paris, Tenn. for construction of a factory building. (Reported by Harry S. Berry, State Engineer.)

Low bid (gross construction)	$97,016	92,420	4.7

Allowing for a grant of $25,000, the PWA plan saved the city $20,400, with "the additional advantage of putting more payroll money into circulation in the community."

Municipal Operation of Privately Built Water System

From data furnished
By M. E. Linton
Commissioner of Water and Light, Topeka, Kans.

THE water system of Topeka, Kans., has been owned and operated by four different private water companies since the franchise was granted in 1881. The first company, with all stock owned locally, built a well 60 ft. in diameter, a pumping station and 15 miles of mains. Eastern interests acquired it in 1890 and made some improvements, but seven years later the plant was sold under foreclosure for $1,500,000 to another eastern combination, which issued bonds for $1,900,000. Seven years later the property was again sold to satisfy creditors, and the following year was bought by the city for $620,000.

Although these private companies failed to make a financial success of the system, the city has done so, although *the rates charged are today and have been throughout practically identical with those charged by the private companies at the time of their failures.*

The department issued no bonds until 1920, but built out of the department's revenue over fifty miles of water mains, a 10-million-gallon storage reservoir and a 15-million-gallon pump. The increase in revenue which made this possible was due chiefly to two causes: First—The percent of water metered was increased from less than 50 percent to more than 78 percent. Second—The plant was operated more efficiently and economically; the cost of chemicals, for example, decreased from $17 per million gallons to $12, although the water is softer than at any time in its history.

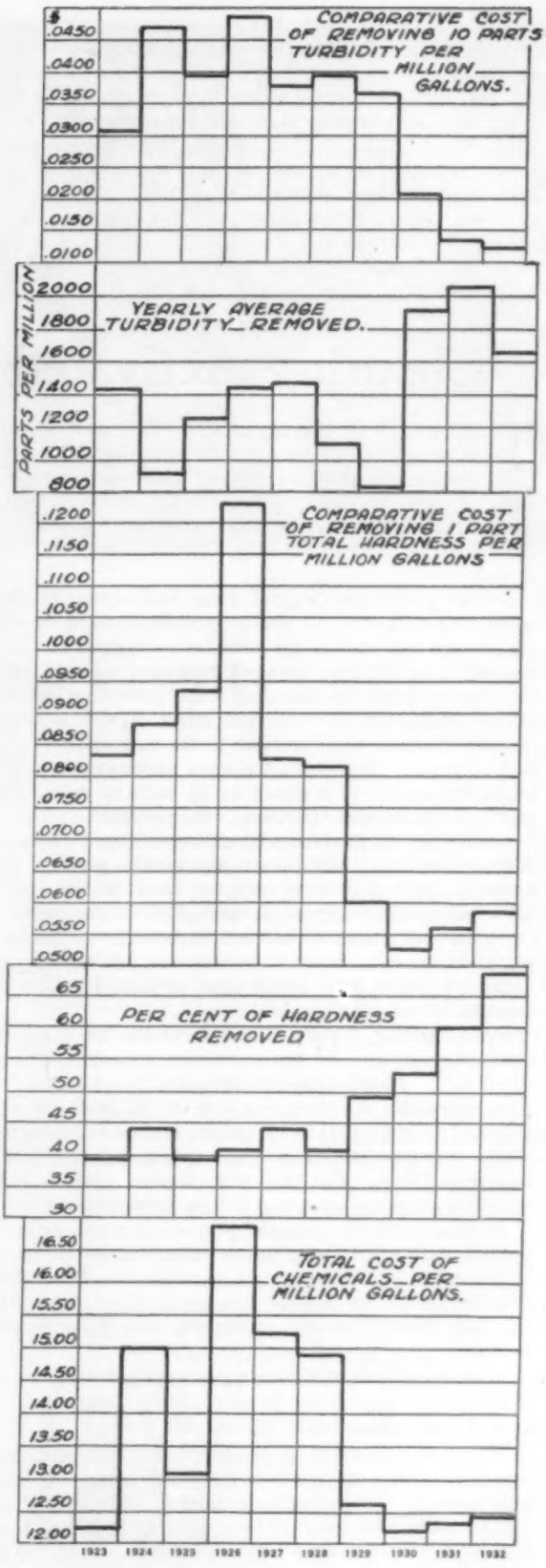
Following a report of consulting engineers in 1920, the department issued $915,000 worth of bonds for very material improvements, but will pay these off from revenue by the year 1940.

From 1905, when the system was purchased, until the adoption of the commission form of government, it was handled by a water works commission of three members.

Growth of the System Under Municipal Ownership

When the city purchased the plant in 1905 it comprised wells and pumping stations at Harrison street and at West End; and 40 miles of mains, with 322 fire hydrants, tapped for 3,837 services. During the next few years the mains from the plant to the town were relaid to protect them from floods; a new crank and fly wheel engine was installed at the West End plant, and new wells and a low-lift pumping system were installed.

Following a report by Black & Veatch, consulting engineers, in 1920, an intake pier and filtration plant were built at a cost of $537,000, and several miles of mains were laid costing $380,000. At present the supply is



Graphical presentation of operation results of Topeka Water Works.

normally obtained from the Kansas river, pumped through a short 24-inch line and discharged over an aerator, then flows to settling basins and from them to two sets of filters, and the effluent to a clear water well.

The low-lift pumping plant consists of three electrically driven Allis-Chalmers single-stage centrifugal pumps, one of 6 m.g.d. and two of 3 m.g.d. There are four roughing filters with a total capacity of 16 m.g.d. and 8 rapid sand filters with 8 m.g.d. capacity, allowing for 25% overload.

The high-pressure pumping equipment consists of two Allis-Chalmers crank and fly-wheel steam pumps with rated capacities of 8 m.g.d. and 15 m.g.d. respectively, and three electrically driven Worthington single-stage centrifugal pumps, two with a rated capacity of 5.75 m.g.d. each and one of 11.5 m.g.d. capacity operated as a booster in connection with the other two.

In 1931 a 10,000,000 gallon reinforced concrete reservoir was put into service, together with pumping equipment consisting of three Fairbanks-Morse single-stage centrifugal pumps with capacities of 1 m.g.d., 5 m.g.d. and 7 m.g.d. respectively.

Cleaning Activated Sludge Air Diffusers

THE life of porous plates and tubes used as air diffusing mediums in activated sludge plants would probably be almost limitless, since the material of which they are composed is stable in sewage; but the pores more or less slowly become clogged and should be cleaned out or the diffusers must be discarded.

Porous plates are clogged from both sides; on the under side with soot, oil and pipe scale brought by the compressed air; on the top with ferric hydroxide (settled out from alkaline sewage), lime and organic matter. Porous tubes are found in some cases clogged by grease, soap, fibrous waste and other organic matter, probably because their position in the tank differs from that of plates. The deposit always penetrates into the plate, frequently to a depth of ⅛ inch or more; the more porous the plate the deeper the penetration.

Scrubbing the surface with dilute hydrochloric acid without removing the plate only partly restores the permeability. One city recently tried the use of a blow torch, which caused a flaking off of the surface layer of the plate, which was composed of quartz; plates made of aluminum grains can not readily be flaked off in this way. Either kind of plate is apt to be cracked by non-uniform heating.

Sand-blasting, using alundum grains in place of sand, has been more or less successful if the plates were dried first. In one case the permeability of a clogged plate was 6 cu. ft., increased to 9 cu. ft. when the top side had been sand blasted, and to 11.2 cu ft. when the under side also had been. (The original permeability had been 15.0). The thickness of plate removed was 0.055 in. from the top and 0.049 in. from the bottom.

It seems probable that the permeability can be completely restored if the plates or tubes can be removed. Where soot, pipe scale and oil are found in the bottom side, and ferric hydroxide, lime and organic matter in the top, the following treatment has been recommended:

1. Soak in 33% HCl for three to four hours.
2. Wash.
3. Fire to about 1,000° C.

The acid removes the pipe scale, ferric hydroxide and lime; washing removes the excess acid; firing removes the organic or carbonaceous matter. The firing requires a suitable kiln or furnace, such that no flame can impinge directly on the plate or tube, and ½" to 1" space is left around each unit for the circulation of gases for removing the carbonaceous material. Firing generally is continued for 12 to 16 hours.

The effect of this treatment on three typical lots of clogged plates is shown in the following table:

	Permeability Values		
Plate	*A*	*B*	*C*
As received	1.5 cu. ft.	5.5 cu. ft.	2.5 cu. ft.
HCl (33% sol.)	7.5 cu. ft.	10.5 cu. ft.	—
Firing to 1000°C	13.5 cu. ft.	14.4 cu. ft.	8.5 cu. ft.

The final permeability values were within 2 cu. ft. of the original before use.

If, in a given case, organic matter is the only clogging agent, firing treatment alone would probably suffice.

It is reported that one treatment plant is using nitric acid to oxidize organic matters, fats, soap, etc. found on tubes. Other plants boil tubes in 15% solutions of caustic soda, and dissolve out the saponified fat in boiling water, restoring the tubes to about 70% of their original permeability. One tube, reduced to 2.3 cu. ft. permeability, was raised to 12.0 by boiling in 15% NaOH, and to 18.2 by firing at 1,000°C. Another was raised from 8.5 to 18.1 by NaOH, and to 32.0 by firing.

The above is from an article by Wallace L. Howe, of the Research Laboratories of the Norton Co., published in its bulletin "Aeration and Filtration." Discussing this, Mr. Howe says: "No one treating procedure can be recommended to fit all cases, since the character of the deposits is dependent on the conditions attending the use of the diffuser."

Porous tubes can readily be removed and replaced. Porous plates, on the other hand, are generally grouted in place and are difficult to remove; but recently consideration is being given to designs of plate holders which will permit the ready removal of the plate for cleaning, which "will undoubtedly result in longer life of the diffuser and an increased operating efficiency of the sewage plant."

Malcolm Pirnie Is Deputy Administrator of the N. R. A.

In our November issue, page 25, we referred to Malcolm Pirnie as "deputy administrator of the P.W.A." Mr. Pirnie is deputy administrator of the N.R.A., and we apologize for making this slip. We endeaver to keep straight the distinctions between the several groups of letters which the administration has put out—N.R.A.—P.W.A — F.E.R.A. — T.V.A — R.F.C. — C.C.C. — A.A.A.—more than a dozen up to date; and hope to avoid any similar slips in the future.

Good drainage is an essential in highway construction. This illustration shows how ditches were constructed in Medina County work

Pay-as-You-Go Highway Construction by Medina County

By R. E. House
Medina County Surveyor

OF A total of 816.0 miles of roads in Medina County, Ohio, only 24% was improved in 1925. The state highway system amounted to 110.2 miles, and the county and township totaled 705.8 miles, of which 608.8 were unimproved dirt roads.

By Dec. 31, 1933, 75% of the roads in the county will have been improved, and instead of 608.8 miles of unimproved roads, there will be but 210.99 miles. By the end of 1934, at which time the program will be completed, there will be but 170 miles of unimproved roads in the county.

Financial Aspects of Eight Years of Progress

In November, 1925, Medina County voted a 2-mill levy to run for 5 years, the money derived therefrom to be used solely for the construction of secondary or feeder roads. At the time of passing this, the county commissioners pledged themselves to use the proceeds of this tax equally in all townships. Construction started in 1926, when about 20 miles of secondary roads were built.

During the five years that the 2-mill levy was in effect, it paid approximately 40% of the total cost of construction. Additional funds, amounting to 36% of the total, were obtained by property owners' assessments at the rate of $2,000 per mile. This was levied first as a flat rate of $100 against each land parcel, while the balance was placed on the abutting property in proportion to the valuation of each parcel as shown on the tax duplicates. The remaining 24% of the cost was paid in by the townships. During the first five-year period, bonds were issued in anticipation of the collection of the property assessments. Aside from that the program has been conducted essentially on a pay-as-you-go basis.

In 1930, a 1½ mill levy was voted to run three years.

In 1932, the first year that the proceeds of the 1½-mill levy was available, the program was drawn up as usual, but on a reduced basis. Re-appraisal of the real estate by the auditor of the county in 1931 had reduced the tax assessment from $60,000,000 to $41,000,000, which reduced the income still further. (Townships, however, levied property assessments as they saw fit.) However, construction was continued as before.

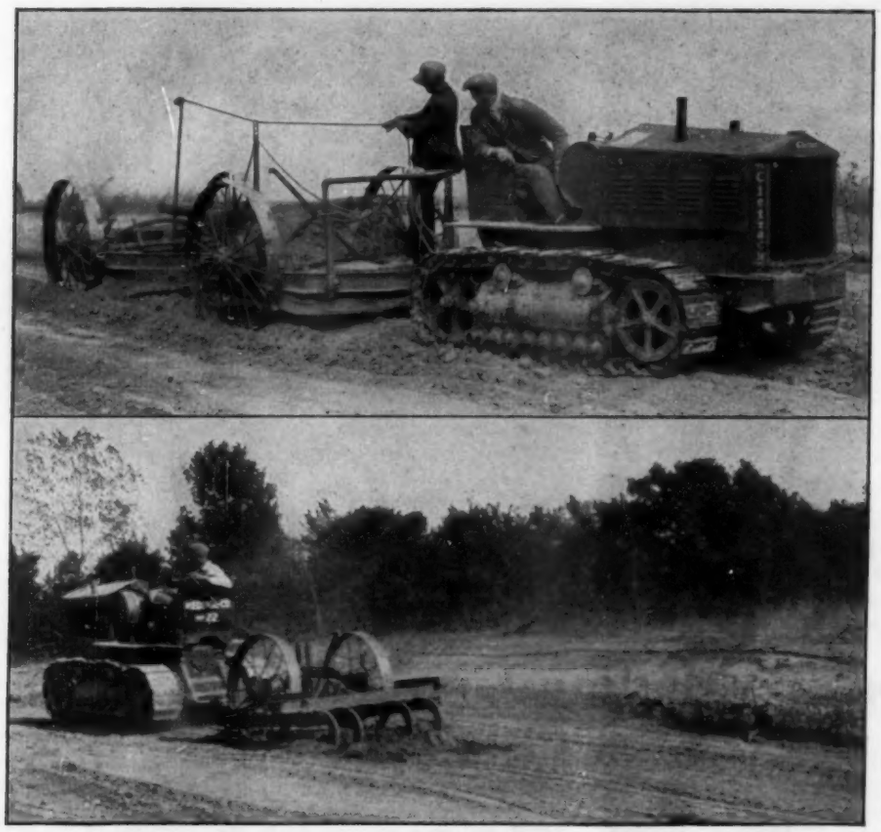
The cost of construction of this work during the eight years that the program has been in force amounts to approximately $1,780,000. This has been done without creating any bonded indebtedness, but on a pay-as-you-go plan.

Construction Data

The majority of the roads in Medina County have a right-of-way width of 60 ft.; roadway width of 26 ft. from berm to berm, with very little crown. Ditches have a 1½ to 1 slope, 1 ft. bottom width. In construction, loose limestone, slag or gravel is placed on the subgrade to a width of 14 ft. and bladed over the road, keeping a uniform cushion about 1 inch deep, the rest of the material being bladed to the sides in windrows, to be bladed onto the road as needed. Under traffic, the road metal spreads to a total width of 18 to 20 feet, giving an ample two-lane roadway. Two miles received a Tarmac surface treatment in 1933 (0.5 gal. of Tarmac CT per square yard), one of which was 8 years and the other 7 years old, and on these the surfacing material was placed to a width of 18 feet.

The general specifications of the State Highway Department were adopted for all work. The roads were widened, drainage ditches constructed where necessary, and 1,800 to 2,000 yards of gravel spread on the road surface, 3 inches deep and 14 feet wide. Additional material was placed as directed by the county surveyor, in those places where it appeared necessary.

The grubbing, clearing, grading of the roadway, fill



A wheel scoop above and a road ripper below, both hauled by Cletrac 35 tractors building Medina County roads.

and borrow, shoulder construction, placing of cast iron culverts, preparing drives and approaches as necessitated by the new grades, construction of culverts and building of bridges were done by county forces, except in a few cases. The purchase and application of materials was done by contract.

Guard rails were placed where needed on all roads and warning signals erected at curves and intersections.

All maintenance work on these roads, including cleaning of ditches, maintenance of shoulders, mowing weeds, placing additional surface material and maintaining the surface is done with county forces. The cost of this work is covered by proceeds from the gas tax and vehicle license fees.

For the construction, the county uses two Austin Western and two Adams 12′ graders drawn by two Caterpillar tractors (a 60 and a 10-ton) and two 60-80 Cletrac tractors. Three Austin Western rotary scrapers, three Euclid rotary scrapers, two 1-yd. Warco scrapers, one porcupine scarifier and one Killifer No. 8 Road Ripper. The power used is furnished by one 2-ton Caterpillar, one Cletrac 40-30, three Cletrac 15's, one Caterpillar 20 and one Cletrac 30 tractor. The heavy equipment is moved on a 10-ton Williams trailer, drawn by a 3-ton International truck. We use three International 6-speed special trucks, two International 2-ton trucks, one Aviation Army truck, one Chevrolet pick-up truck and one small Ford truck for dynamite.

Gasoline and oil are distributed with a 1-ton Chevrolet tank truck. Gasoline is purchased in tank cars and placed in a storage tank, which results in a considerable saving to the county.

For excavation work on bridges, channel changes and roads, a Bay City crane clam shell mounted on a Sterling truck is used.

For maintaining and blading surface, etc., seven Austin-Western International, one Allis Chalmers and one Galion International motor graders and one Briland International road plane are used.

A York reclaimer, a Davey air compressor and several other miscellaneous pieces of equipment are used.

In most cases stone spreaders have been used for spreading stone on roads, attached to the truck when unloading, and the material spread in the center of the road and bladed over the surface with motor graders, excess material being bladed into windrows on the berms. In cases where additional small amounts of material are placed, it is merely "tailgated" from the truck and bladed over the surface.

This construction, and the maintenance of constructed roads, erecting signs and guard rails, moving weeds, etc., has enabled the county to furnish considerable unemployment relief. The average number employed during the season of 1933 has been about 170. During winter months, when weather permits or as conditions require, an average of 60 are employed.

In general, the citizens have been very favorable to this work, although some have found the assessments hard to pay during the depression. The program had the endorsement and good will of the business men of the towns and villages. During the early part of the construction, there were many and insistent demands by property owners for good roads past their properties.

Difficult Sewer Siphon Construction

In constructing an inverted siphon sewer under the river Clwyd for the town of Rhyl, North Wales, the contractor used the coffer-dam method, dividing the crossing into three sections. Thirty-inch cast-iron pipe in 12-foot lengths were used for the sewer. Steel sheet-piling was used for the coffer-dam. Considerable difficulty was experienced in preventing leakage under the piling of the first section, causing some delay.

Meantime, because of the obstruction to the floor of the river caused by the coffer-dam, the bed of the river was scoured out by the current to such an extent as to be 5 feet below the proposed invert level of the sewer in mid-channel. To remedy this, the bottom at this point was brought up to the grade of the sewer with concrete, and the steel sheet-piling was left in up to the level of the top of the sewer, being cut off there with an under-water cutting flame.

THE WATER WHEEL

FOLLOWING are the essential features of the important articles of the month having to do with water works design, construction and operation and water purification, arranged in easy reference form and condensed and interpreted. Published every month to include articles appearing during the preceding month.

CONCRETE water tanks, cylindrical in form, must withstand circumferential stress, and if the wall is rigidly fixed to the base, cantilever action also.[9] This makes a mathematical calculation of stresses very complicated. Mr. Leeper has introduced modifications to simplify the formulas with little loss of accuracy, and make them more usable.

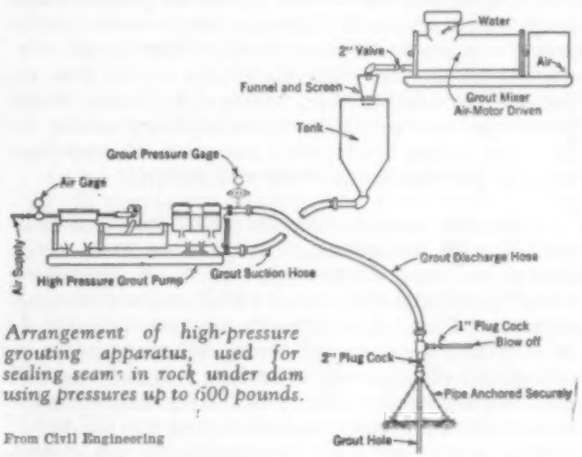
The permeability of the concrete can be reduced to practically zero if proper precautions are taken.[11] Mr. Vermeule tested ten drums with 13-inch concrete walls and concluded that well-made concrete so proportioned that the volume of cement exceeded by 20% the voids in the sand, hydrated lime be added equal to 10% the volume of sand, and the mortar be 20% in excess of the voids in the crushed stone (approximately a 1:2:4 mix), will withstand a pressure of 200 pounds without any leakage whatever. After being under pressure for 48 hours, all pressure should be removed for two weeks, probably because, during the first pressure, some of the finer particles were carried into the concrete and massed a little back from its inner face. All reinforcing bars should be thoroughly cleaned of grease and dirt and dust, and none come nearer than 4 inches to the exterior surface. A mixture of 1:1½:3 without lime was as tight as 1:2:4 with lime.

Grouting dam foundations and joints is very desirable in the case of high gravity dams on rock, providing "a seal or curtain along the upstream face of the dam to prevent leakage and uplift pressure."[10] For the Calderwood dam, grout was applied under pressure up to 600 lbs. For holes up to 30 ft. depth, jackhammers were used, and diamond drills up to 240 ft. depth with 1 9/16 in. cores. For the latter, jackhammer holes 8 or 10 in. deep had 2 in. nipples cemented in them or caulked in them with lead wool and the drills started in these nipples. High-pressure grouting was preceded by a thorough sealing of surface seams and cracks by the low-pressure method. In testing the relative efficiency of low and high-pressure grouting, a hole which refused to take more grout under low pressure received 400 additional bags of cement when high pressure was used.

"The equipment for high-pressure grouting consisted of a mixer, a No. 5 screen, a storage tank, and a high-pressure pump. For the mixer, the low-pressure grout machine was used, set at such an elevation as would allow the mixed grout to flow by gravity through the screen into the tank," from which it flowed by gravity to the pump. "A mixture of four bags of cement in 3 cu. ft. of water, used for all the high-pressure grouting, was about as thick as could be handled by the pump."

Water works tunnels can now be constructed as cheaply in rock, using recent developments in mechanical equipment, as through clay where compressed air and shield methods are used.[1] "The new mechanical equipments referred to are the mechanical mucking and stone loading equipment, the mechanical cement mixing and placing units and the new loading and unloading equipment. . . . For dependability during construction and freedom from foundation interferences later, the rock tunnels are of course much superior to the clay tunnels."

Metering in Chicago reduced the consumption of a given district from 28,100,000 gpd in 1920-'24 to 11,260,000 gpd in 1927.[2] Of the saving, 12,051,800 was attributed to plumbing leakage and willful waste and 4,788,199 to underground street leakage. *Leakage was located* by listening with an aquaphone upon rods in contact with the main. Where the mains were at extreme depth and where the leaks were waterbound the "dye method" was used. At present "the surveys consist in listening with an aquaphone on all hydrants, valves and on at least one service pipe at the roundway stop-cock every one hundred feet. If a leak is heard on a service pipe, the roundway stop-cock is closed and opened to determine whether the leak is between the main and the curb cock or between the curb cock and the premises." The present underground street leakage is estimated to be 8.8% of the average pumpage.



Arrangement of high-pressure grouting apparatus, used for sealing seams in rock under dam using pressures up to 600 pounds.

From Civil Engineering

Peak consumption in outlying high-service districts of Milwaukee has been provided for by constructing a 6 m.g. ground-level storage tank and four 30 m.g.d. motor-driven centrifugal booster pumping units.[4] The high service district lies 8 to 15 miles from the main pumping stations. This plan was the cheapest of four considered: 1—A major pumping station and construction of tunnels and discharge mains. 2—Construction of 16 elevated steel tanks on high land. 3—Several ground storage tanks with small booster stations. "It is contemplated that the station and tank will be used only during the summer months covering the period of high peak consumption. The tank, mains and equipment will be drained over the winter period and the station will be closed."

Centrifugal pumps began finding wide application in water works pumping plants 25 or 30 years ago and

during the last 20 years have practically excluded every other kind of pump.[5] During this period the most important developments have been: 1—Efficiencies of small pumps have been improved 15 to 20% and of large ones 8 to 10%. 2—Single-stage pumps are used with high efficiencies for heads up to 250 ft.; 20 yrs, ago, seldom for heads above 100 to 125 ft. 3—The useful range, particularly in regard to suction lifts, has been extended by applying increased knowledge of factors affecting noise and cavitation. 4—By proper selection of pump size and speed, more satisfactory operation at high suction lifts can now be obtained. 5—There has been improvement in the efficiency of the driver, particularly steam turbines and especially the small ones used with water works pumps. The Rankine cycle efficiency is 20% higher than 20 years ago, "and this, coupled with the modern high steam pressures and temperatures results in duties that make steam turbine drive for water works pumps a very attractive and economical proposition." The high-speed helical gear reduction invariably used on turbine-driven water works pumps has been in continuous satisfactory service for 20 years, during which period improvements have been made in gear-cutting methods and design.

Anthracite coal, effective size 1 mm. and uniformity coefficient 1.6, has been used for *filtering* water at Columbus, O., since August 30, 1932. C. P. Hoover reports[36] that coal for one bed cost $550, while sand would have cost $594. After continuous operation for 13 months there has been no lumping but considerable incrustation; effective size of surface material was 0.95 mm. and uniformity coefficient 1.2. Originally the maximum wash rate required to float the bed was 12" to 15" rise per minute, but since incrustation 20" can be used. The quality of filtered water, physical, chemical and bacterial, has been no different from that delivered by the sand filters.

A clear-water well at Williston, N. D., set deep so as to receive the filtered water by gravity was found to cost twice as much as pumping from a suction well beneath the filters into a clear well set at normal ground level, capitalizing the power cost at 6%.[37]

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The Digestion Tank

A Digest of the Sewerage Literature of the Month

SLUDGE dewatering on sand beds "is not as inexpensive a process as it is usually thought to be,[20] Sludge may be dewatered by continuous filtration on vacuum filters at an over-all cost that is frequently less than that incurred by sand-bed operation, and, in all but the smaller plants, at a comparable cost." Using data from seven plants, both large and small, and including fixed charges of 4½% interest and 3.7% amortization, Mr. Irving calculates the cost per ton of dry solids to vary from ($2.31 operating cost + $1.79 fixed charges) $4.10 to ($4.21 operating costs + $5.63 fixed charges) $9.84; the last including $1.27 ($2,658 per year) for repainting glassovers, (which seems very high).

Chemical treatment can be entirely inoffensive, "the space required is so small that it is entirely feasible to construct a superstructure over the entire plant," and it is possible to locate such a plant "in practically any district where a relatively small area of land is available,"[18] eliminating long outfall sewer. Concentration of sewage very often varies by the ratio of 1 to 10 or more; and the degree of purification of the effluent which is required may vary from complete treatment during low stream flow and high temperature, to a negligible degree in periods of cold weather and high stream flow. Chemical treatment permits varying the degree of treatment to meet conditions and requirements, including those caused by trade wastes, while biological treatment is inflexible.

In addition, chemical plants can be constructed at substantially lower cost, require but a fraction of the space; existing plants can, at low cost, be converted for chemical treatment which will increase their capacity or degree of purification, and total costs (including fixed charges) will compare very favorably with other types of secondary treatment.

"Chemical conditioning of sludges as an aid in dewatering operations is already rapidly becoming established; and, with sludge incineration perfected, dewatering of sludges on vacuum filters will become the most satisfactory as well as, what appears to be, the most economical means of disposal of sludges not subject to economical processing into fertilizer" says Enslow [22]. In order to reduce peak overloads on biological plants, for which the use of the bypass is often inadvisable if not forbidden by the State health board, preliminary chemical precipitation can be used as a standby method to "remove the tough parts of the sewage and leave the more tender morsels for biological attack."

Disposal of sludge at the Prittlewell works of Southend, England[5], is effected by pumping it from new sedimentation tanks (which contain Dorr-Oliver sludge removal equipment) to older tanks at a higher level, to reduce the water content, and the more concentrated sludge from these is then pumped 4½ miles through a 9" c.i. main to a field where it is run into trenches for drying; from which, when dry enough, it is removed and sold to neighboring farmers. The present dry-weather flow is 3½ m.g.d. but the plant will treat 5½ dry-weather and 16½ storm water flow. Power for pumping is obtained from an adjacent refuse destructor, supplemented when necessary by oil engine and electrically driven pumps. Grit deposited in two 20'x20' grit tanks is "raked by revolving arms to one side of the tanks, raised by oscillating rakes in a comparatively dry state, and finally elevated by an endless chain of buckets into an overhead hopper in an inoffensive and comparatively dry state." The entire plant was built in the bottom of a large gravel pit to receive low-level sewage.

In the Middlesex sewage disposal scheme[8] for treating 80 m.g.d. dry-weather flow, concentrated sludge will be pumped 7 miles to an area of 223 acres, 150 acres of which are completely isolated from the surrounding subsoil by means of a puddle wall carried down to a clay stratum "so that any sludge liquor finding its way into the ground has no outlet other than by a sewer specially provided" for removing it. The reason for this is that the land drains toward the river Colne, which is used for London's water supply. It is proposed to use the activated sludge process for the main work of purification. The entire scheme will cost over $20,000,000.

Sludge digestion tanks at the Saltley works of the Birmingham (England) Drainage Board[34] are "provided with floating gas collectors. The gas is utilized in engines having a total of 950 B.hp. The waste heat leaving the engines in the cooling water and in the exhaust gases is utilized to increase the rate of digestion. For this purpose alkaline water drawn from the digestion tanks is passed through a heat exchanger, and conveys the heat back to the sludge."

Flies breeding in filters have been studied for a year by Dyson and Lloyd of Leeds University, [6] who believe that insect larvae and worms, "by grazing over the surfaces of the stones of the bed, afford the bacteria ever fresh ground to make new growth and so renew their physiological youth" which tends to increased bacterial

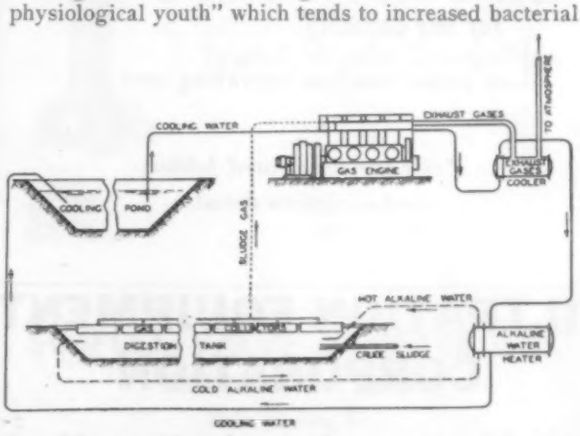

Diagram showing method of circulating and treating alkaline sludge liquor at Birmingham, England.

activity. (See page 17 of this issue.) Whether or not this is the case, their presence is desirable because of their scouring action alone. The swarms of flies developing therefrom, however are a nuisance, although none of them are dangerous as they do not visit the food of man, (but might drop onto it). The investigations indicated that "excessive fly breeding might be reduced by using as a filling smooth pebbles screened to exclude all small gravel. Advantage should be taken of the dispersing power of the wind" by not allowing shady groves of trees in proximity to them. "Sheet spraying is preferable to drop spraying" (using a traveling distributor) as tending to drown more of the flies emerging from the bed. It may be that excessive fly breeding could be prevented by resting the beds and letting the deposits in them dry, without reducing their efficiency.

Filters are favorable to the growth of fresh-water and damp fauna because the temperature is equable, animals which prey upon insect larvae (birds, fish, dragon flies, etc.) are few, and food supply and other favorable conditions are tolerably uniform through the depth of the bed. In the beds at Knostrop the most abundant species of fly was *Spaniotoma minima*-black, 1.5 mm. long, which was caught at the rate of 1,000 per sq. ft. per day. Of *Psychoda* they caught 300 to 400 per sq. ft.; also 119 *Metriocnemus*, and much smaller numbers of several other species.

Concerning resting filters, W. D. Scouller stated that a bed at Huddersfield had been out of action for a fortnight and apparently free from flies, but on starting the filter again Psychoda began to come out of it and in 15 minutes it was impossible to see across the bed because of them. They collected in the shelter of walls and he had seen "masses of flies 1 ft. thick under walls and smelling like rotten meat." As to use of gravel instead of slag for a filter medium, the former might harbor less flies, but was less efficient in promoting bacterial purification. In America[85] "Generally the plants using the smaller top stone have operated with less fly nuisance and have not been subject to pooling to any greater extent than those filters which have used coarser stone."

"*Wasting of excess activated sludge* to the primary clarifier greatly reduces the volume of sludge to be digested," * but at Salinas, Calif.[21] "increases the solid content and oxygen demand of the settled sewage and thus increases the cost and difficulty of operating the activated sludge process." There the cost was increased by $3.90 per million gallons for air-compressing power and $1.90 for lime. Also, to minimize the difficulties, it was necessary to have an operator in attendance for 18 instead of 9 hours, at an increased cost of $8 per m.g., because it was desirable to introduce the activated sludge to the primary tank at as low a rate as possible and "it is difficult to design equipment for wasting that is free from clogging difficulties," necessitating constant attendance while wasting.

As aeration is far more costly to operate than sedimentation, "it is desirable to have the control of aeration as independent of the functioning of sedimentation as possible. Wasting in this manner makes aeration more, instead of less, dependent on sedimentation."

Relatively shallow tanks are most efficient for settling crude sewage, but when excess sludge is wasted to a primary tank "it is necessary to maintain sludge blank-

*But Imhoff says[86]: "If the excess activated sludge is dealt with in this way the sludge digestion tanks must be three times as large, because the sludge is doubled and contains much more water. The sludge drying beds must be quadrupled." Imhoff probably is comparing this practice with disposing of the excess sludge other than by digestion; Haseltine, with turning the excess sludge directly into the digestion tank.

ets 1 to 3 feet deep to secure sludge concentration" requiring deeper tanks; also larger ones, giving a longer detention period for a greater amount of liquid, seem to be necessary.

"When bulking occurs this system of disposing of excess sludge partially or completely fails. Both the solid and the B.O.D. content of the settled sewage are greatly increased, thus making the control to overcome bulking more difficult."

Mr. Haseltine believes that "some means of concentrating the excess sludge without introducing it into the primary sedimentation tanks is to be desired." Lagooning is being tried at Salinas, but if this should prove unsatisfactory he expects to try the method developed by Goudey and Bennett which, although requiring the use of a separate clarifier and about 25 lbs. of chlorine per m.g. of sewage treated, is estimated to cost only $3.00 to $3.50 per m.g., including maintenance and depreciation.

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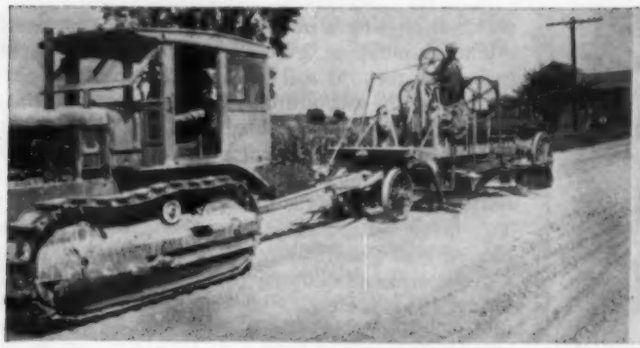


Scarifying road after distributing pulverized clay and loose material

Mixing pulverized clay and scarified road material.

Stabilizing Michigan Gravel Roads with Clay and Calcium Chloride

By E. E. Blomgren and J. W. Kushing

Maintenance Engineer, and Research and Testing Engineer, Michigan State Highway Department

Stabilization of the 7.4 miles of gravel road on M-36 from Mason to Dansville, Michigan, was started on July 31, 1933 and finished on August 12, 1933.

The work involved uniform incorporation of about 1,250 cubic yards of nearby clay into the existing gravel to a depth of 2½ inches and a width of 18 feet. This was accomplished by scarifying the road surface and mixing the pulverized clay with loosened material.

The selection and quantity of the clay which was used were determined by standardized soil tests made on samples from available clay deposits and from the existing gravel wearing course on the road.

After dampening the mixed road materials with water and shaping the road surface, 2½ tons per mile of calcium chloride was applied.

The total cost of stabilization with clay and calcium chloride was $2,820.44. This amounted to $381.13 per mile or $0.036 per square yard. This cost was high compared with other similar Michigan projects, the expense of which ranged from $200 to $300 per mile.

THE steady increases in traffic intensity and traffic speed which have taken place on our highways have added greatly to the maintenance problem on our gravel road surfaces. Many roads of the traffic-bound type, such as gravel, crushed stone and slag, have had a large part of the fine binder soils whipped out of their surfaces, resulting in the development of a loose cover of stones or pebbles. In dry weather this condition exists to an aggravating degree in localities where natural soil binder is lacking in the gravels and shoulder materials. Roads that are covered with this loose material require frequent costly blading and remain smooth for only a short time after the grader has passed over them. Usually, attempts to control the dust hazard on such surfaces are only partly successful.

Where shoulder material containing a considerable amount of clay has been worked into the gravel surfaces and when moisture is retained in the gravel by the use of calcium chloride, an improvement results. Likewise there is a marked reduction in the loss of binder soils and in the consequent development of loose cover.

In order to present the vehicle operator with the smoothest, firmest and safest riding surface obtainable under existing conditions, it has been found advisable to keep the unbound material bladed off the road in windrows on the shoulders during dry weather. Such windrows, however, are themselves a traffic hazard, they generally decrease the width of the riding surface available for the use of the motorist, and they interfere with transverse run-off of rainfall on rolling longitudinal grades.

The use of clay as a soil binder for consolidating the loose material on the road has not been general heretofore. But methods of testing which are now available make it simple accurately to correct conditions where lack of binder prevails, and progress in the understanding of the principles underlying ideal gravel road composition has been very rapid during the past two or three years.

Basic facts which were established by the U. S. Bureau of Public Roads have been applied extensively by the Michigan State Highway Department on a number of projects. The work, in which the Soil Stabilization Department of The Dow Chemical Company has rendered assistance, has led to the development of an improved type of low-cost gravel road surface which was not considered attainable a few years ago.

This surface may be said to consist of a mixture of graded aggregates embedded in a cementitious filler which is composed of a carefully balanced mixture of sand, silt and clay. The coarse aggregate may be pebble, crushed stone or slag; material under ¾ inch in size is preferred. The fine aggregate is usually coarse sand or stone screenings. It is to the "soil fines" (the

material passing a number of 40 sieve) that particular attention must be given. This fraction, sometimes called the natural soil binder, contains the finer sand and all of the silt and clay. The latter material, with a small amount of moisture, supplies the essential cohesion to the mixture. In dry weather, calcium chloride is used as an agent to retain the moisture that is required for holding the binder and aggregates in place. To convert an ordinary gravel road surface to the improved type generally requires the thorough mixing of a predetermined quantity of a cohesive clay with the existing road material. When properly proportioned, mixed and shaped, the result is known as a stabilized gravel surface.

Stabilization of An Old Gravel Road

The following description of a recent stabilization project of the Michigan State Highway Department, namely, 7.4 miles of M-36 in Ingham County from Mason to Dansville, will show in detail the best practice developed to date. This project was undertaken in order to demonstrate the possibilities of general improvement and stabilization of an old gravel surface.

Condition of the Original Road

The road had a 24-ft. grade, gravelled practically the entire width. The original surface was uniform in general appearance for the full length of the project. It consisted of a fairly well bound base containing a large quantity of over-size material ranging in size from one inch to 6 inches diameter. The surface was slightly wavy and bumpy in places but in general was fairly smooth. Loose gravel sufficient to make a cover one-half to one inch deep had been bladed into windrows on the edges of the road.

It was our desire to add sufficient clay binder to this road to convert the surface into a highly stable sand-clay-gravel mix for a depth of 2 to 3 inches. At the same time we wished to thoroughly remove the over-size stones.

Samples of the road gravel were taken from three holes at each of three stations. The holes were located on the center line of the road and about four feet on each side of the center. Gravel from the top 2½ inches was taken for the sample. The holes were then dug through the surface to determine the depth of gravel remaining on the road, which depths were found to be 7″ at two stations and 6″ at the third.

Selection of Clay and Determination of Quantity Required

An extensive survey of the possible clay locations in the vicinity of this project was necessary before suitable material was located. In order to be useful for this purpose, a clay supply must meet the following requirements:—

(1) Its properties, mainly its cohesion and its mechanical analysis, must be suited to the gravel with which it is to be mixed.
(2) Its location must be accessible and as close to the job as possible.
(3) It should not cost over five to ten cents per cubic yard at the pit.
(4) It must be available in sufficient quantity.

A clay deposit located at an average distance of six miles from the road was found to be very satisfactory for this project in every respect. Although it contained a fair amount of fine sand, this was not objectionable as the amount of fine sand in the gravel was relatively small.

In choosing a clay for this purpose, it must be borne in mind that the material is to be selected mainly for its binding value, or cohesion, which can be measured by soil tests which give a value known as the plasticity

index*. It has been found that a clay having a plasticity index of twenty is sufficiently cohesive for this purpose.

Tests of clays for cohesion are valuable, not alone for comparing their relative binding values but also for determining the quantity of clay required by the gravel under consideration. Weighed samples of the road gravel are treated in the laboratory with measured quantities of each available clay, and similar tests for cohesion are performed on the resulting mixture. In general, an attempt is made to adjust the cohesive property of the mixture so that the plasticity index lies between seven and ten. The clay should coat all of the larger particles, such as the sand and gravel, with finely divided cementing material, and hence gravels having a high sand content require large clay additions, while those containing smaller amounts of sand or some clay need less new clay material to provide the necessary cohesive properties to the final mixture.

The clay that was chosen for use on this project had a plasticity index of twenty-four, a fairly high cohesive value for clays in this locality. Tests of gravel-clay mixtures showed that an addition of fourteen per cent by weight of this clay to the gravel samples was required to give a plasticity index of nine to the resulting mixture. This amounted to 170 cubic yards of loose clay per mile of road, eighteen feet wide, to treat two inches of base material plus less than one inch of loose gravel.

Delivery of Clay

Before the clay is mixed with the gravel it must be finely pulverized, and before it can be pulverized it must be dried. On previous projects it had been the practice to do the drying and pulverizing operations on the roadway. Usually the available loose gravel was bladed onto the road, the clay spread on this, and the resulting mixture bladed off into windrows until most of the clay had been delivered to the job. In this case, however, an effort was made to dump the clay on the sides of the road, and thus to keep the center of the roadway clean.

A half-yard power shovel was used for loading the clay. Sixteen to eighteen two-yard dump trucks were required to keep the shovel busy. One of two men stationed in the pit checked the quality of the clay, discarded some of the large stones and guided the shovel from sandy or other objectionable clays. A second man at the pit filled out delivery slips for the truck drivers, who were paid on a yard-mile basis.

On the road, two men attended to the delivery of the clay, received the truck drivers' delivery slips, and recorded the delivery location.

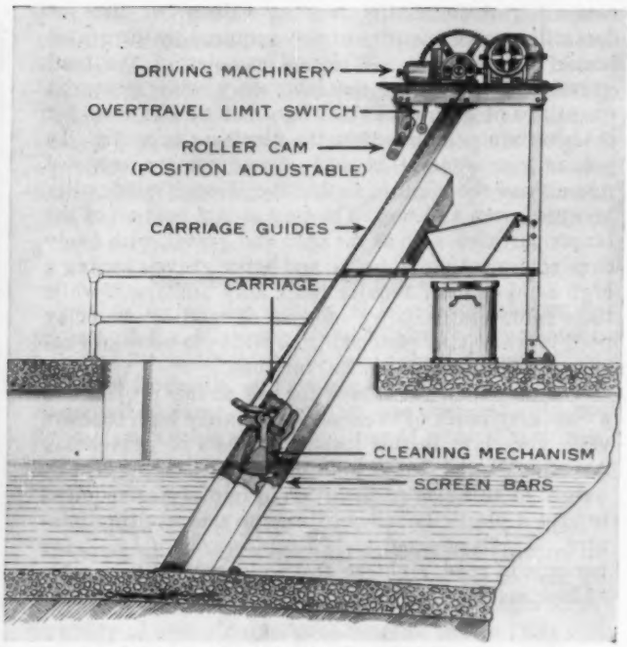
To add the clay at the rate of 170 cubic yards per mile, it was necessary to distribute each two-yard load over 120 lineal feet on one side of the road. To facilitate this operation, a heavy cord, one hundred and twenty feet long, with a heavy weight on each end, was used as a marker. Each truck approached the string at a speed of about ten miles per hour with the box tilted. When he reached the first marker, the driver opened the tail gate and usually delivered the clay within the required distance. When the material was dry it dumped freely, but when it was damp it was necessary to drive more slowly and poke the clay out with shovels.

The clay application was started July 31 and by August 2 the material had been applied on all but about one-half mile of the project. A heavy rain at this time resulted in a loss of about one hundred cubic yards of

*Public Roads, Vol. 12, No. 8, Oct., 1931.

(Continued on page 39)

[Short Talks with Sewage Plant Designers]



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Actual photograph of the hand cleaning operation at the Baltimore plant before the installation of Link-Belt Straightline mechanically cleaned bar screens.

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Do you make regular use of the Readers' Service Dept.?—see pp. 43-46

Clay and loose material bladed onto shoulders of the road

Clay distributed along sides of road ready to begin work

Michigan Road Stabilization

(Continued from page 35)

material from the windrows into the ditches. This was replaced when the clay was being applied to the remaining one-half mile.

Equipment Available for Clay Pulverizing, Scarifying, Stone Raking, Mixing and Shaping

1 Motor grader
1 Leaning wheel grader with 20 h.p. caterpillar tractor motor
1 Mechanical rake, drawn by above 20 h.p. caterpillar motor
1 Gravel roller, drawn by truck
1 Two-yard truck for picking up stones
1 Scraper or float truck
1 Sprinkler tank truck

Drying and Pulverizing Clay

The motor grader was used to spread the clay on the road from the windrows. As the material in the windrows had been partially dried and was then slaked by the rain, the drying and pulverizing could be done with relative ease. The scraper truck and roller usually finished pulverizing the clay on one mile in about three to five hours.

Scarifying, Mixing and Removing Over-size Stones

After pulverizing, the clay and loose gravel were spread uniformly over the road surface preparatory to scarifying. The scarifier teeth on the mechanical rake were then set to tear up about two inches of gravel.

Mixing was accomplished by the combined use of the motor grader and the leaning wheel grader or the rake. The loosened gravel and clay were bladed out from the center to the shoulders and back into the road three times before the mixing was considered complete. The material was then spread over the surface and the over-size stones were bladed to the edge of the road using the rake drawn by the 20-horsepower caterpillar. The over-size stones were picked up with forks by a crew of eight men, loaded into a truck and hauled away.

Shaping, Compacting and Treating with Calcium Chloride

On previous similar projects it has been customary to shape up the finished mix and treat with calcium chloride the following day, unless rain was expected. However, a firm, hard surface could never be obtained until a rain had moistened the sand-clay-gravel thoroughly, and traffic had compacted it while damp.

The more recent experience of a number of Michigan counties has showed that water should be added artificially whenever it can be done at a reasonable cost. As a local water supply was available, most of this project was thoroughly dampened artificially in order to hasten consolidation of the stabilized material.

The work was started at the east end of the project. For convenience, the manner of handling the shaping, compacting and calcium cloride treatment, will be described section by section.

Section 1—This portion of the road was scarified and the pulverized clay was thoroughly mixed with the gravel, but the over-size was not removed by night fall, so the mixture was bladed to the shoulders. During the night a heavy rain thoroughly soaked the windrowed material. On the second day following the rain, the mixture was bladed onto the road and partially dried before removing the over-size. During this drying operation some compaction took place, making a clean removal of the over-size stones practically impossible. The mix was still damp enough to compact well after the stones had been removed. The following morning it was bladed, and the large stones that were turned up by the blade were removed. The section was then sprinkled with water at a rate of 2,000 gallons per mile before treatment with 2½ tons of calcium chloride per mile. Except for the extreme east end, where some drying took place before compaction was completed, this section remained in good condition. Following the next rain, sufficient moisture was present so that it could be satisfactorily compacted.

Section 2—The clay on this section was dried and pulverized on the third day following the rain. When the gravel was scarified and mixed with the clay, however, a considerable amount of moisture remained in the gravel. This was an aid to the compaction of the road. It was sprinkled with 2,000 gallons of water in the evening, and treated with calcium chloride the following morning. After some time two short stretches of this section showed lack of consolidation and developed some loose gravel and a washboard surface, probably due to lack of moisture and compaction before chloride treatment. These were placed in good condition after rain supplied the necessary moisture.

Section 3—After the mixing had been finished and the stones raked out of this and the succeeding sections, the mixture was very dry. Although this section was sprinkled with 2,000 gallons of water per mile, and was treated at once with 2½ tons of calcium chloride per mile to prevent loss of the moisture, the penetration of the water was not deep enough to consolidate the entire mat. After a few days the surface started to break up in places, so it was necessary to wet it more during two successive nights. A rainfall after midnight on the second night provided enough additional water to permit shaping with the truck blade. Another ton per mile of calcium chloride was applied the following morning to correct the faulty distribution of the chloride which resulted from the break-up due to the previous dryness.

Section 4—After compacting and shaping this section, the mixture was thoroughly soaked with water during the night. About 8,000 to 10,000 gallons per mile were required to wet the stabilized road material to the bottom. The following morning it was bladed, lightly sprinkled and treated with calcium chloride at the rate of 2½ tons per mile.

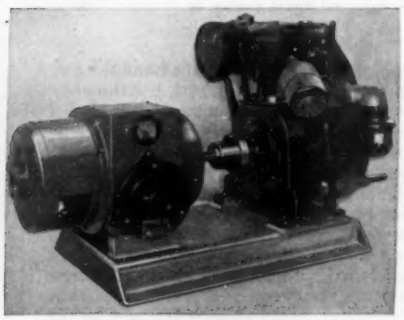
Section 5—When the mixing of this section had been completed and the over-size stones removed, the mixture was bladed into windrows on the shoulders. Water was applied to the base at the rate of 1,000 gallons per mile on each side. The motor grader followed the sprinkler and covered the moist base with one-half to three-fourths of an inch of dry material. This was then wetted and covered with dry sand-clay-gravel as before. The process of wetting and bringing in dry material was continued until four cycles in all had been completed. After all the gravel was in place the surface was floated with a truck blade, compacted with a dual-tire truck and wetted again before treatment with calcium chloride. This is probably the best way to apply water artificially as it insures distribution of water from the bottom to the top of the mat. The total water used on this section was approximately 8,000 gallons.

The final installment of this article giving itemized costs and laboratory control data will appear in the January issue.

New Equipment in Pictures

Lighting Plants for Construction:

Portable lighting plants, 400 watts to 60 kw, 35 to 120-volt current, are now being manufactured by Harnischfeger Corp., Milwaukee, Wisc. Push button or manual starting is available. Diesel power is available for the 35 and 50-kw sets, consuming less than half the fuel necessary to operate gasoline driven units.



Harnischfeger Lighting Plant

High reserve capacity, with non-flickering current, economical operation and simple design are among the advantages claimed for this line of lighting equipment.

An Oil-Mix Pavement Roller:

Towed behind trucks, motor patrols or pneumatic tired tractors, the Bros rubber tired oil-mix roller quickly compacts the surface of fresh or disked oil-mix pavement, leaving the surface in excellent condition for immediate use by speedy traffic. The nine tires on the roller, plus the towing equipment, cover a path about eight feet wide. Three trips over each portion will usually give a perfect riding surface and will seal against entrance of moisture.

The use of this roller is not limited to freshly mixed roads, but it can be used for compact shoulders of old roads, and for roads torn up by disking or bladed without reoiling. The platform of the roller may be loaded with sandbags or other weights to get the desired compaction. The shipping weight is about 2,500 pounds. The gross load permissible, including roller is about 7 tons. Fuller details of this equipment and data on operation on state highway work are available from the manufacturers, Wm.. Bros Boiler & Mfg. Co., Minneapolis, Minn.

Mov-Mor Dirt Scraper:

Dirt still has to be moved before construction proper can begin. The Davenport Locomotive & Mfg. Corp., Davenport, Ia., has just brought out a new revolving type scraper which is especially fitted to today's construction. It is cheap; it can be used for scraping lightly, digging deeply, spreading the load or dumping completely. It is made in seven sizes, ranging from 12 to 56 cubic foot capacity.

Mov-Mor Scraper

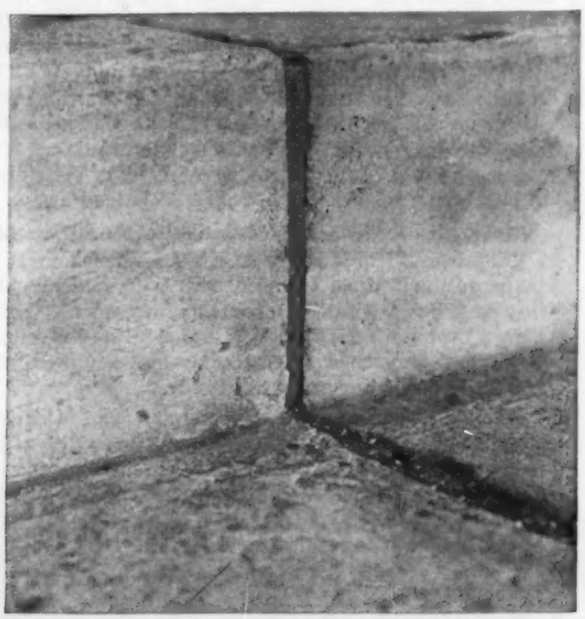
A view of a curve protected by Truscon Guard Rail

Cork Expansion Joint:

Nine points of superiority are claimed for the Johns-Manville cork expansion joint for concrete construction: Enduring resiliency, in that over long periods of time and repeated compressions, the cork joint recovered to 90% of its original thickness; easy compressibility under light loads; ability to withstand without rupture heavy loads; no evidence of deterioration under freezing and thawing; not softened under high temperatures; cannot be squeezed out of position; does not mar appearance under any condition; easy to handle and work; and a considerable reduction in maintenance costs.

Specificatons for the J-M cork expansion joint are included in a booklet now available, which also contains curves showing the results of many tests. Booklet BMW-200, Johns-Manville Co., 22 East 40th St., N. Y.

Bros Oil-Mix Pavement Roller



Johns-Manville Cork Expansion Joint

Engineering Booklets

WINTER CONSTRUCTION COLORING CONCRETE
ICE CONTROL WATER PURIFICATION SEWAGE TREATMENT

Winter Construction:

The Portland Cement Association, 33 West Grand Ave., Chicago, Ill., has issued a very instructive folder on winter concreting. An important part of the information are complete specifications for making, placing and curing concrete in winter and full information, not a part of the specifications, for protection of reinforced concrete work in cold weather. Copies free on request.

• • •

HiBlak for Coloring Concrete:

A 4-page folder chuck full of interesting and worthwhile information on this subject has been published by Binney & Smith Co., 41 East 42nd St., N. Y. It gives laboratory results on tests for strength of concrete when using HiBlak, and other materials data.

• • •

Water Purification Equipment:

International Filter Co., 59 East Van Buren St., Chicago, Ill., has just published a folder covering their full line of equipment for the modern water purification plant. A sectional view of a filter plant, showing various Infilco equipment in place, is of considerable interest.

• • •

Crushing, Screening and Washing Plants:

The Wisconsin Fdry. & Machine Co., Madison, Wisc., has issued a folder of 12 pages describing their triple service plant for crushing, washing and screening work.

• • •

Enduro Chromium Steels:

Republic Steel Corporation, Massillon, O., has issued a booklet on Enduro 4-6% Chromium Steels. These possess resistance to corrosion, acid attack and scaling. This steel is available in usual forms and can be worked into almost any shape desired. The booklet mentioned gives a lot of information about this material, which ought to have a number of uses in connection with sewage treatment.

• • •

Ice Control Practice:

A timely and interesting circular from the Columbia Alkali Corporation, Barberton, O., telling how to make ice skidproof through the use of calcium chloride. The directions are brief, clear and to the point.

• • •

Aluminum Welding and Riveting:

Two booklets just published by the Aluminum Co. of America, Pittsburgh, Pa., give the essential information on these subjects.

Aluminum for Truck Bodies:

The lighter weight of aluminum makes it economical to use this material instead of steel for truck bodies. This booklet not only gives engineering designs for truck bodies, in detail, but gives actual operating records showing how many operators have found that the greater truck pay load possible with aluminum more than pays for the higher initial cost.

• • •

Oil Burner Units:

The torch-type, circular-type, low-pressure and Venturi oil burner units, as manufactured by Littleford Bros., Cincinnati, O., are described in Bulletin I-10, just issued. These units are especially designed for winter work.

• • •

Blowers for Sewage Treatment:

Roots-Connersville-Wilbraham, Connersville, Ind., has issued Bulletin 23-B11, which is devoted to a description of their equipment as applied to sewage treatment plants. The first three pages contain illustrations of heavy duty blowers in the activated sludge treatment plants at Peoria and Springfield, Ill., and Salem, O. One of the three rotary positive blowers in the plant at Springfield is direct driven by a 6-cylinder engine operated by sludge gas, for which a saving of $6,380 per year in power costs is claimed by the engineer. Approximately 45 installations using R-C-W equipment is listed. Meters and centrifugal pumps are also illustrated and described.

• • •

Service Boxes:

A new booklet, just issued by the Central Foundry Co., illustrates and describes a new development in service boxes. There is no lug in the top section to break off and no strain in the brass screw. Consequently broken and lost cover trouble is eliminated. Write Henry Hoeltge, 420 Lexington Ave., N. Y., for further data.

• • •

Truscon Steel Liner Plates, Data Book No. 5, gives much information data on most modern methods of executing underground structures, through any kind of non-supporting ground, in any standard shape and in sizes from 45 inches up. Poling plate equipment is also described. This is a valuable booklet for anyone contemplating tunnel work. Truscon Steel Co., Cleveland, Ohio, will supply this data book on request.

• • •

Portable Air Compressors, by Worthington, 120, 240 and 310 cubic feet displacement, are described in a folder just issued by Worthington Pump and Machinery Corp., Harrison, N. J.

More New Equipment

Austin-Western High-Speed Snow Plow

High Speed Snow Plow:

A high speed snow plow that fits any 1½-ton truck is a recent product of The Austin-Western Road Machinery Co., Chicago. Tapered and deeply curved to pick up, "spiral" and throw the snow, this plow can be worked at the highest operating speeds; pronounced curve of blade successfully prevents snow from clouding the windshield and clogging up radiator. A few easy strokes by driver within cab operates hydraulic (oil) pump to raise blade; turning a small thumb screw valve lowers blade rapidly or slowly as desired or locks it in place. A simple but rigid attachment to front of truck makes for quick mounting to, and easy removal from, truck. Novel toggle release permits obstructions to pass under blade when it strikes man-hole cover, traffic marker, etc.; blade readily assumes its normal position when truck is backed up.

The Truck and the Job:

Proper gear ratios, tire sizes, wheelbase and other features for maximum economy for any given job have always been important. Guess-work in selecting these account for heavy operating costs. In order to substitute certainty for guesswork, the Reo Motor Car Co., Lansing, Mich., have developed a slide rule which solves the problem quickly and accurately.

Workability Composition:

Warren Bros. Co., Boston, Mass., well known in the highway world, have issued information regarding a new product—workability composition. The use of this facilitates the construction of bituminous pavements during cold weather, and also permits the production of any desired kind of cold-lay paving or repair mixture which may be stored and used as needed.

Asphaltic mixtures in which this composition is used may be mixed with any desired gradation of materials. No special equipment is required, as it can be used in any standard hot-mix plant. The procedure is the same except that aggregate temperatures should be lower—200F. to 250F. Slightly less asphalt is used, and workability composition is added in the amount of about 10% to 12½% by weight of the asphalt used. Slightly less than the usual amount of asphalt is required.

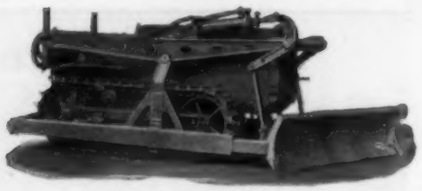
Fuller information can be obtained on request from Warren Bros.

Trailbuilders and Bulldozers:

Wooldridge Trailbuilders and Bulldozers, long established in the National Parks, Forestry Service, and Western Lumber Camps, are now manufactured and distributed by the Continental Roll and Steel Foundry Company, East Chicago, Indiana. Continental-Built machines are available for the Allis-Chalmers, Caterpillar, Cletrac Tractors and McCormick-Deering TracTrac-Tor. The sales offices have been opened at 332 South Michigan Avenue, Chicago, Ill., for the Industrial Equipment Division, with R. W. Moon, as manager.

Continental-built equipment uses the new "Dynamic" steel which will stand up under tremendous and continuous shock. This "stamina" steel is especially adapted to dirt and rock moving equipment operating with crawler tractors.

Wooldridge Hydraulic Trailbuilders have established distinctive records of low-cost work. That is due in a great measure to the ease of maneuvering the blade. The Wooldridge blade is hydraulically powered both up and down and also adjustable to many horizontal angles. The Trailbuilder has an angling blade that can be used either side or operated as a straight blade bulldozer.



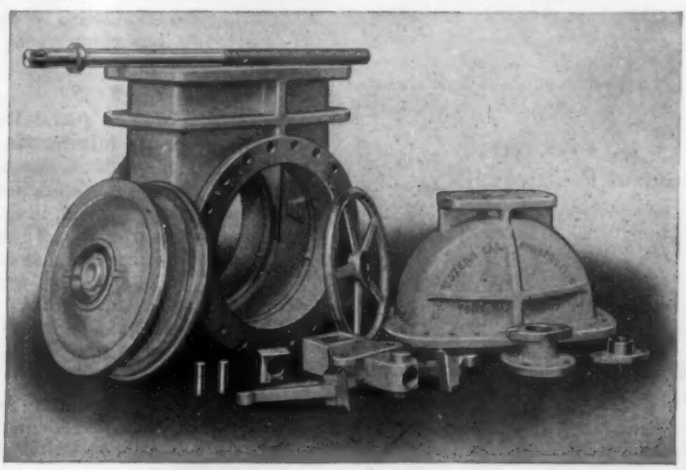
The Wooldridge Trailbuilder

"Western" AWWA Gate Valves:

Designed primarily for filtration plant and water works use, this valve meets—and in many instances exceeds — the "Standard Specifications for Valves" adopted by The American Water Works Association. Greater strength, durability and efficiency were the real specifications aimed at. Following are some important data regarding them:

1. 150 pounds per square inch, maximum water working pressure; tested to 300 pounds per square inch hydrostatic pressure.
2. Cast iron parts made from superior quality nickel iron — tough, close-grained; tensile strength 35,000 to 40,000 pounds per square inch.
3. Diameter of valve stem equals or exceeds AWWA specifications; all threads milled in a lathe for accuracy, smoothness.
4. Symmetrically dished discs, supported at center, free to rotate; so designed that valve may be installed in any position.
5. Simple, direct action; opening requires less effort than closing, due to pressure on discs being relieved before discs slide off seats.

Bulletin 305, published by the Western Gas Construction Co., Fort Wayne, Ind., for more than forty years makers of difficult-service valves, describes these in detail.



"Western" AWWA Gate Valve

Readers' Service Department

To help you in your work, any of this **INDUSTRIAL LITERATURE** will be sent **FREE** upon request.

It is a good practice to check this list regularly because descriptions of new bulletins are always being added.

Road and Street Maintenance

Asphalt Heaters

8. Full information concerning their tar and asphalt kettles, surface heaters, oil burners and other road maintenance equipment will be sent promptly on request by Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

Asphalt Mixing Plants

10. Precise engineering control of bituminous pavement construction is provided at low initial cost by the new Blaw-Knox (Madsen) portable asphalt mixing plant which is described and illustrated in a new catalog just issued by Blaw-Knox Company, 2019 Farmers Bank Building, Pittsburgh, Pa.

200. For general construction and maintenance, the Original Improved "Hotstuf" Asphalt Heater, an economical oil burning heater. Mohawk Asphalt Heater Co., 56 Weaver St., Frankfort, N. Y.

Bituminous Material Handling

201. "Handling Bituminous Road Materials." This is a new and valuable booklet covering handling and heating of bituminous materials for low cost road construction and maintenance. Full data regarding Cleaver-Brooks equipment. Cleaver-Brooks Co., 740 North Plankinton Ave., Milwaukee, Wis.

Dust Control

209. "3000 men put back to work in a single county." A new folder just issued by the Solvay Sales Corp., 61 Broadway, New York City, outlining a road program which is a relief program. Sent promptly on request.

210. "How to Maintain Roads," by the Dow Chemical Company, Midland, Michigan, is a manual dealing thoroughly with dust control, road building and maintenance.

211. "Dust Control," a concise, handy pocket reference on control of dust by use of 3C Calcium Chloride. Illustrated. Issued by the Columbia Products Company, Barberton, Ohio.

212. "Wyandotte Calcium Chloride Prevents Dust the Natural Way,"—a publication, fully illustrated, treating on Dust Control, economical road maintenance and methods of application, issued by the Michigan Alkali Company, 10 E. 40th St., New York City.

Dust Laying

213. Full information regarding the use of Solvay Calcium Chloride for effectively laying dust The booklet, "Solvay Calcium Chloride, a Natural Dust Layer," 24 pages, 5½x8, covers application, economies, etc. Sent without cost. Solvay Sales Corporation, New York.

Emulsion Sprayers

214. A complete line of emulsion sprayers is described in Bulletin No. G-5 recently issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio. Littleford Emulsion Sprayers will spray any type of asphalt emulsion used for penetration patch work or curing concrete. They are also used to spray silicate of soda and weed exterminators.

Surface Heaters

220. The "Hotstuf" three in one, combination Tool, Asphalt and Surface heater is described and its use illustrated in Bulletin 16. Mohawk Asphalt Heater Co., 56 Weaver St., Schenectady, N. Y.

Oil Burner Units

500. Torch-type circular-type, low pressure and Venturi burners are all described and illustrated in bulletin I-10, just issued by Littleford Bros., 452 East Pearl St., Cincinnati, Ohio. Explains uses, how to operate, etc.

Steel Posts

160. Steel Posts for highway guard rails, fences and other purposes. Catalog and data book. Sweet's Steel Company, Williamsport, Pa.

Noiseless Manhole Covers

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

Road and Paving Materials

Bituminous Materials

226. Full details concerning the uses and advantages of Lincolnite Pulverized Petroleum Asphalt, Linco Road Oils, Cutback Asphalt Cement and Penetration Asphalt Cements will be sent free on request by Lincoln Oil Refining Co., Box 251, Robinson, Ill.

227. "Asphalt for Every Purpose," a 44-page illustrated booklet describing Stanolind Asphalt products. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

228. A new booklet has just been issued by The Barrett Co., 40 Rector St., New York, describing and illustrating the uses of each grade of Tarvia and Tarvialithic. 32 excellent illustrations.

229. A new series of concise and authoritative manuals of construction covering the latest developments in road-mix and surface treatment types as well as the standard asphalt pavements. These contain the best that has been developed by study, research and practical application in all types. Manual 1—Road-Mix Types is now ready for distribution. The Asphalt Institute, 801 Second Ave., New York, N. Y.

229A. Surface Treatment Types, Asphalt Road Construction Manual No. 2. Full details on surface treatments. 14 chapters, 128 pages. The second of those tremendously valuable and handy little manuals put out by the Asphalt Institute, 801 Second Avenue, N. Y. Sent on request.

Brick, Paving

230. Full information and data regarding the use of vitrified brick as a paving material, cost, method of laying, life, etc. National Paving Brick Manufacturers' Association, National Press Building, Washington, D. C.

Concrete Curing

235. "How to Cure Concrete," is a manual of instruction on the curing of concrete pavements. 47 pages. The Dow Chemical Company, Midland, Mich.

Gutters

240. "Brick Gutters and Parking Strips." A study dealing with the problems faced in the proper construction of gutters and how they can be overcome. Covers design, construction and results. Well illustrated. Just issued by the National Paving Brick Ass'n, National Press Building, Washington, D. C.

Jacking Culverts

260. No interruption to traffic, and substantial savings in construction costs are the main advantages secured by using the Armco jacking method to install conduits, drainage openings, and passageways under streets, highways and railroads. "The Armco Jacking Method," describing this modern means of construction and its many applications, will be sent upon request, by Armco Culvert Mfrs. Association, Middletown, Ohio. Ask for Catalog No. 7.

12-33

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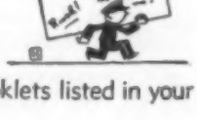

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Maintenance Materials and Methods

270. "How to Maintain Roads," by the Dow Chemical Company, Midland, Michigan, is a manual dealing thoroughly with road building, maintenance and dust control.

275. "Tarvia-K. P. for Cold Patching." An instructive booklet illustrating and describing each step in patching a road with "Tarvia-K.P." 16 pages, illustrated, 3½x9. The Barrett Company, New York.

276. "Road Maintenance with Tarvia." A 56-page illustrated booklet of value to every road man. Shows how almost every type of road and pavement can be repaired and maintained with Tarvia. The Barrett Company, New York.

Construction Materials and Equipment

Asphalt Heaters

9. Illustrated manual No. 11 describes "Hotstuf," the master oil burning heater. The only heater with patented elevated melting chamber for Asphalt, Tar and all bitumens used in road and street construction and maintenance, roofing, water proofing, pipe coating, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Asphalt Mixing Plants

10. Precise engineering control of bituminous pavement construction is provided at low initial cost by the new Blaw-Knox (Madsen) portable asphalt mixing plant which is described and illustrated in a new catalog just issued by Blaw-Knox Company, 2019 Farmers Bank Building, Pittsburgh, Pa.

Asphalt Plants

11. A very complete 24 page booklet covering all five sizes and types of Iroquois Asphalt Mixing Plants which are particularly adapted to meet the needs of municipalities and contractors, providing maximum output at minimum cost. Barber Asphalt Co., 1600 Arch St., Philadelphia, Pa.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subjects suggested by title.

31. "Curing Concrete Roads with Solvay Calcium Chloride," 30 page booklet. Comprehensive. Contains tables, illustrations, suggestions for testing devices. Covers the subject in considerable detail. Solvay Sales Corp., 61 Broadway, N. Y. C.

35. "A report on Current Practice of using Calcium Chloride for curing Concrete Pavements, Bridges, Culverts and Concrete Products." It includes reports from the Highway Research Board, the Bureau of Public Roads and State Highway Departments. Columbia Products Co., Barberton, Ohio.

Concrete Mixer

44. Concrete Mixers, both Tilting and Non-Tilting types, from 3½s to 84s size, The Jaeger Machine Company, Columbus, Ohio.

Crushers

57. Up-to-date information on Stone Crushers, Stone Spreaders, Unloaders, Drags and other contractors' equipment from the Galion Iron Works & Mfg. Co., E. Jeffry Mfg. Co., Columbus, Ohio.

Culverts

60. "In diameters up to 10 feet and larger . . ." just issued by the Armco Culvert Mfrs. Assn., tells a good deal about drainage problems and their solution. 32 pages about drainage and multi-plate culverts.

Explosives

74. "Use of Explosives for Settling Highway Fills. A new booklet which fully explains by diagrams and charts the three methods developed after many tests by the Du Pont engineers, which singly or in combination will quickly and efficiently do your job. Just issued by E. I. Du Pont de Nemours & Co., Inc., Explosives Dept., Wilmington, Del.

Graders

76. Latest information about Galion Motor Patrol Graders, Road Maintainers and Leaning Wheel Graders with hydraulic control is contained in a new series of illustrated catalogs, Nos. 125, 130, 135 just issued by the Galion Iron Works & Mfg. Co., care of The Jeffrey Mfg. Co., Columbus, Ohio.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Joint Filler and Line Marker

88. Bulletin No. G-9 issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio, describes and illustrates their new No. 91 Joint Filler which is used to fill horizontal and center joints with hot asphalt. It can be equipped to apply an asphaltic center line as it fills the center joint. This bulletin also describes the Littleford Traffic Line Marker.

Joint Filling Pot

89. A supplement to Bulletin No. E-5 has been issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio, describing their cone-shaped crack filling pot No. 86-B. The chief feature of this pot is that it is springless—there is no mechanism to get out of order. It is used to fill cracks and joints in concrete pavements and interstices in brick or granite block pavements.

Loaders and Unloaders

97. Portable Loaders and Unloaders. Folders: Nos. 1248, 1298 and 1074 cover Belt Conveyors with channel iron and truss types of framework; No. 1076, Portable Bucket elevators for different classes of work; and No. 1256, the "Grizzly" Crawler Loader for heavy work and large capacities. Link-Belt Company, Philadelphia.

100. Materials Handling and Positive Power Transmission Equipment, giving technical data, list prices and illustrations of this machinery. Link-Belt Co., Chicago, Ill. General Catalog No. 500.

Motor Trucks

105. Full information about their complete line of motor trucks, all powered by six-cylinder "truck-built" engines of uniform valve-in-head design, will be sent promptly. General Motors Truck Co., Pontiac, Mich.

Paving Materials

109. A 36-page booklet with 66 illustrations has just been issued by the Barrett Co., giving full information regarding the making, laying and maintaining of "Tarvia-lithic," the ready-to-lay pavement.

111. "Tarvia Double Seal Pavements." Shows, step by step, the construction of a Tarvia pavement. 24 pages. The Barrett Company, 40 Rector Street, New York.

112. Complete directions for surface Cut Back Asphalt are contained in a 36 treatment and bituminous surfacing with page data book. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

Road Machinery

126. A new picture book of the Austin-Western Line of road machinery showing the application of road graders, road rollers, elevating graders, crawler and wheeled wagons, crushing and screening plants, shovels, cranes and excavators, scarifiers and many small tools, is contained in Catalog No. 1247. Copies available on request at The Austin-Western Road Machinery Co., 400 North Michigan Ave., No. A5, Chicago.

127. "Road Machinery Illustrated." New illustrated bulletins on the motor rollers, three-wheel and tandem rollers, motor graders powered by Caterpillar, Twin City, Cletrac, McCormick-Deering and Fordson tractors, and straight and leaning wheel graders. Galion Iron Works & Mfg. Co., Galion, O.

Rollers

132. A 32-page book in four colors featuring a complete line of road rollers. 8¾ x 11, leatherette cover, numerous action pictures. Buffalo-Springfield Roller Co of Springfield, Ohio.

133. 20-page pocket size booklet showing all types of Buffalo-Springfield motor rollers and scarifiers and their uses.

134. "The Chief," a six cylinder roller of advanced design and construction is fully described in an illustrated catalog just issued by the Galion Iron Works & Mfg. Co., care of The Jeffrey Mfg. Co., Columbus, Ohio. Gives complete details of the very latest development by this company.

Sand and Gravel Washing Plants

140. Seventy-page catalog giving complete information regarding Sand and Gravel Washing Plants, stationary and portable. Those interested in such equipment should have a copy. Link-Belt Co., Chicago, Ill.

Shovels, Cranes and Excavators

145. The Austin Badger, a new, fully convertible ¾ yard crawler shovel, made by The Austin-Western Road Machinery Co., 400 North Michigan Ave., No. A5, Chicago, is fully described and illustrated in their Bulletin No. 1236.

146. Link-Belt Co., Chicago, Ill., has issued Book No. 1095, which describes and illustrates their complete line of Gasoline, Electric, or Diesel operated shovels, cranes and draglines. 910 S. Mich. Ave.

Steel Posts

160. Steel Posts for highway guard rails, fences and other purposes. Catalog and data book. Sweet's Steel Company, Williamsport, Pa.

Tires, Truck and Tractor

165. Speed and economy in use of solid, cushion and pneumatic tires and tubes for trucks, cars, tractors, graders and other road machinery. Government Sales Department of the Goodyear Tire & Rubber Company, Inc., Akron, Ohio.

Snow Removal

344. "Control Winter Drifts"—A new folder giving full details regarding use and construction of the Mattson snow fence has just been issued by the Mattson Wire & Mfg. Co., Peoria, Ill. Illustrated in two colors.

345. "Standard and Heavy Duty Reversible Blade Snow Plows for Motor Trucks," a new bulletin just published by the Monarch Mfg. Co., East Front St., Wilmington, Del. Illustrated. Contains complete descriptions and specifications.

349. "The Answer to the Snow Removal Problem." It gives full details of the Frink type S snow plow for trucks. Carl Frink, Mfr. of Clayton, N. Y.

359. Galion Iron Works and Mfg. Co., Galion, Ohio. Details, prices and catalogs of their snow plows adaptable to any make of truck.

News of the Engineering Field

W. G. Stromquist, since 1928 sanitary engineer of the Jefferson County Board of Health, Birmingham, Ala., has resigned to accept an appointment with the Tennessee Valley Authority.

The firm name of Pearse, Greeley and Hansen has been changed to Greeley & Hansen. This firm has long been among the leaders in hydraulic and sanitary engineering consulting practices. The offices remain at 6 No. Michigan Ave., Chicago, Ill.

Peter J. Hurtgen, since 1916 city engineer, and since 1919 director of Public Works of Kenosha, Wisc., died Nov. 15. Mr. Hurtgen was a progressive and able engineer, active in civic affairs in Kenosha, treasurer since 1928 of the International Association of Public Works officials, and a valued contributor to this magazine. He was 59 years old.

T. Chalkley Hatton died Nov. 11th as the result of an automobile accident a few hours earlier. For fourteen years he had been chief engineer of the Milwaukee Sewerage Commission, and is most widely known and will be longest remembered for the remarkably thorough investigation of the activated sludge process conducted under his supervision, and for the construction of the Milwaukee sewage treatment plant with its many novel features. In 1927 he retired as chief engineer; but had been retained as consulting engineer in connection with designing an enlargement of the plant.

Mr. Hatton was 73 years old, and had been a prominent figure in sanitary engineering for over 40 years, having taken charge of a $1,700,000 sewerage system for Wilmington, Del., in 1889. He was a past president of and had held many offices in the American Society of Municipal Engineers, and had been a prominent figure in the American Society of Civil Engineers.

Morris R. Sherrerd died suddenly of a heart attack on Oct. 20th in his 68th year. He had for years been one of the leading water works engineers of the country, was a past president of the American Water Works Association, of the American Society of Municipal Engineers and of the New Jersey Society of Professional Engineers. He had been connected with the water works of Newark, N. J., since 1895, most of the time as chief engineer. There were few large water works projects or state commissions in New Jersey of which he was not a consultant. At the time of his death he was chief engineer of the State Water Policy Commission, and had been chief engineer of the New Jersey Water Supply Commission and the North Jersey District Water Supply Commission. He had declined the position of deputy chief engineer of the Panama Canal and of the same position on the Ashokan Dam. He had been employed as consultant by the Port of New York Authority, the Regional Plan of New York and scores of smaller projects.

An Investigation of the Flood Flow Characteristics of North Carolina Streams

Thorndike Saville, New York University, N. Y., and John D. Watson of the University of North Carolina, have collaborated in the preparation of a paper on this subject, which was presented before the American Geophysical Union. It is a complete and interesting discussion of the results of many years of study on the flow of various North Carolina rivers—the Yadkin, the French Broad, the Tuckasegee, the Little Tennessee and the Hiwassee. Discharge records for these streams cover a period of 30 years or more. Drainage areas vary from 410 square miles to 3400. The purpose of the study has been to determine if a significant relation appeared to exist between duration-of-flow curves when plotted as ratios of mean flows, the degree and variation of such relation and if this relation could be expressed by Barrows' equation. And if it could not, to develop an equation which would define any relation found to exist.

The American Road Builders' Association

The annual convention of the American Road Builders' Association and the exhibit will be held at the Stevens Hotel, Chicago, Ill., January 22-25, 1934. Exhibits will be limited to those that can be located in the hotel.

This will be one of the most important conventions yet held, from the viewpoint of the formulation of plans for an aggressive campaign for the continuation of an adequate highway program. Further details will be issued from the ARBA office, and latest information regarding the convention will appear in the January issue of PUBLIC WORKS.

American Cyanimid Acquires Filtration Equipment

The American Cyanamid Company announces the acquisition of the Filtration Equipment Corporation, which owns the Laughlin Equipment and Process of sewage treatment by Chemical-Mechanical methods. Officers of the new corporation are: President, R. C. Jeffcott; Vice-Presidents, W. C. Laughlin, J. T. Fetherston, John W. Boyer; Treasurer, C. B. E. Rosane; Secretary, W. S. Weeks.

The new corporation will operate as a separate division of the parent company and actively promote further installation of this equipment and the modern processes of sewage disposal as exemplified in the plant installed and successfully operating at Dearborn, Michigan. Headquarters will continue to be maintained at 350 Madison Avenue, New York City.

Work for Engineers on the Coast and Geodetic Survey

The CWA and the Coast and Geodetic Survey are undertaking a widespread program of local control surveys which will require the employment of approximately 15,000 men, about a third of them engineers, for about three months, with a number of parties surveying in each state. The Coast and Geodetic Survey will appoint a local supervisor in each state, who will select the engineers needed from a list furnished him by the CWA. Engineers wishing positions on this work should communicate at once with their State Civil Works Administrator. (See page 10.)

Letters to the Editor

PWA Data

Nov 11, 1933.

Our grant has been approved by PWA for surfacing roads. How do we proceed to do this work by force account? Wire answer.

County Engineer, Michigan.

Ed. Note: The information asked for went forward at once by wire from our editor who was in Washington at the time. Each such project is handled separately. Force account work is permitted, but must be approved for each case.

More PWA Data

Nov. 23, 1933.

In an unincorporated town of about 150 population, could a PWA loan be obtained by an individual or a corporation for the purpose of constructing a light and power plant to serve the town?

The project would give employment to 10 or 12 men for about four months and would cost approximately $8,000.

C. W., Montana.

Ed. Note: You never know till you try. Full information on procedure was sent the same day the letter was received.

Lineal or Linear

Nov. 2, 1933.

On page 53 of the October issue, under "The Wheeled Roller" the expression "per lineal inch" is used. The dictionary says that *lineal* means "in line of descent" as father, son, grandson.

I would like to see a dissertation on "lineal" and "linear," as they should be used in engineering practice, in your magazine.

F. W., City Engineer,
Wisconsin.

Ed. Note: Reference to our dictionary discloses that *lineal* is permissible, but that *linear* is preferable. On the other hand, while inviting further discussion of this subject, we might point out that the inch may be considered the *lineal* descendant of the mile, rod, yard and foot, and in such sense also might be proper. We invite further discussion and thank Mr. W. for his close reading of PUBLIC WORKS.

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Sanitary Engineering

Activated Carbon, Aqua NUCHAR

380. For low cost removal of tastes and odors from potable waters. Used by more than 400 municipalities. For literature address Industrial Chemical Sales Company, Inc., 230 Park Avenue, New York.

Ferric Chloride

382. Full information concerning the experiences in the use of ferric chloride for use in sludge conditioning and in coagulating sewage will be sent promptly by Innis, Speiden & Co., 117 Liberty St., New York, N. Y.

383. Loughlin Clarifying Tanks for the more complete removal of suspended solids from sewage and industrial wastes at lower cost are described in a new bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

Sludge Drying

385. Relatively dry cake sludge in demand for fertilizer is produced by automatic continuous vacuum filters like those used in Milwaukee, Houston, Chicago, Gastonia, N. C., Charlotte, N. C. Write for literature. Oliver United Filters Inc., 33 West 42nd St., New York, N. Y.

Activation and Aeration

390. A booklet of value to sanitary and chemical engineers describes Norton Porous Mediums of bonded fused alumina (strong chemically stable, uniformly permeable) and their use in aeration of water and sewage. Norton Co., Worcester, Mass.

Glass Covers

393. Full details regarding the use of Lord & Burnham Glass-Covers at Dayton, Ohio; Highland Park, Ill.; Fostoria, Ohio; and Bloomington, Ill., are given in bulletins Nos. 10, 11, 14, 15. Issued by Lord & Burnham, Irvington, N. Y.

Jointing Materials

402. Full details concerning No. 1 Korite for sealing sewer pipe joints so that they will be permanently tight. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

Manhole Covers and Inlets

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Meters, Sewage and Water

405. Just issued. Every sanitary engineer should have a copy of this new 32 page booklet describing the applications, types and distinctive features of the new Bailey meters for sewage treatment and water supply. Sent promptly. Bailey Meter Co., 1027 Ivanhoe Road, Cleveland, Ohio.

Pipe Forms

407. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pumping Engines

413. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Screens, Sewage

417. The simple, automatic, Loughlin self-cleaning traveling screen is fully described in a new bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

418. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill. Book 642.

419. An illustrated booklet showing installations, and complete details regarding the 19 exclusive improvements which are featured in Shevlin Fine Disc Screens will be sent promptly by the Shevlin Engineering Co., Inc., 227 Fulton St., New York, N. Y.

420. A useful new bulletin for all those interested in sewage disposal, describing some of their proven equipment such as self-cleaning bar screens, grit conveyors, sludge collectors and shredders, has just been issued by the Jeffrey Mfg. Co., Columbus, Ohio. Includes diagrams and many illustrations.

Screens

424. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., Chicago, Ill.

Sludge Bed Glass Covers

426. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Main Office, Elizabeth, New Jersey. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Conditioning

382. Full information concerning the experiences in the use of ferric chloride for use in sludge conditioning and in coagulating sewage will be sent promptly by Innis, Speiden & Co., 117 Liberty St., New York, N. Y.

Treatment

429. A new series of bulletins describing their full line of sewage treatment equipment—Fine Screens, Schofield Bar Screens, Vacuum Filters for Sewage Sludge, Decarie Screenings Incinerators, Schofield Bar and Fine Screens, Vacuum Filters for Sewage Filtration and Pneumatic Ejectors for Sewage Screenings—are ready for distribution on request to Municipal Sanitary Service Corp., Room 2703, 155 East 44th St., New York, N. Y.

430. Separate bulletins showing their many lines of sewage treatment equipment will be sent promptly by The Pacific Flush Tank Co., Chicago and New York. The latest is No. 110 describing tray clarifiers.

431. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters Inc., 33 West 42nd St., New York, N. Y.

433. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 910 So. Michigan Ave., Chicago, Ill., and Philadelphia.

if

you want descriptions of equipment or materials not listed in this section, write the type desired on the coupon on page 43 and mail. We will see that you receive literature from the leading manufacturers.